MPŠ
MEDNARODNA PODIPLOMSKA ŠOLA Jožefa Stefana

Jožef Stefan
INTERNATIONAL POSTGRADUATE SCHOOL IPS

2004 – 2014

Poslanstvo Mednarodne podiplomske šole Jožefa Stefana:
ustvarjanje znanja ter materialnih in kulturnih dobrin

Foto / Photo: M. Smrke

The mission of the Jožef Stefan International Postgraduate School:
the creation of knowledge, material and cultural wealth

MEDNARODNA PODIPLOMSKA ŠOLA Jožefa Stefana (MPŠ)

Jožef Stefan INTERNATIONAL POSTGRADUATE SCHOOL (IPS)

2004 – 2014

Ustanovni partner:

INSTITUT JOŽEF STEFAN (IJS)
Ljubljana, Slovenija

Founding Partner:

JOŽEF STEFAN INSTITUTE (JSI)
Ljubljana, Slovenia

Jubilej raziskovalno-izobraževalne ustvarjalnosti

Prof. dr. Vito Turk
Predsednik MPŠ
IPS President

V letu 2014 praznuje Mednarodna podiplomska šola Jožefa Stefana (MPŠ) deset let svojega delovanja. Če upoštevamo ustvarjanje podiplomskih del na Institutu »Jožef Stefan« pred tem, potem je jubilej pol stoletja + deset let!

Institut »Jožef Stefan« (IJS), ustanovljen leta 1949, je največja slovenska raziskovalna institucija z izjemnim mednarodnim ugledom. Vselej je posvečal posebno skrb izobraževanju mladih raziskovalcev v vodilnih raziskovalnih središčih najbolj razvitih držav. Od tam so prinašali vrhunske raziskovalne metode in tehnike ter načine znanstvenega razmišljanja.

Odlične znanstvene dosežke in njihov učinkovit prenos v procese proizvodnje in storitev lahko zagotovijo samo vrhunsko usposobljeni kadri. Zato so najboljši raziskovalci IJS postali sodelavci – profesorji Univerze v Ljubljani (UL), IJS pa je široko odprl dostop do vrhunske raziskovalne opreme najboljšim študentom UL. Do leta 2004 je bilo na IJS opravljenih 692 doktorskih del, 808 magistrskih del ter 2060 diplomskih del – skupaj 3560 del, za katere so bile diplome podeljene na univerzi.

IJS za to pomembno sodelovanje ni dobil priznanja, zlasti pa ni mogel uspešno uveljavljati svojih raziskovalno-izobraževalnih predlogov na inter/multi-disciplinarnih področjih, za katera novi znanstveni dosežki nudijo vrhunska temeljna znanja, obenem pa odpirajo možnosti za razvoj visokih tehnologij. Zato je bil IJS leta 1996 pobudnik in leta 2003 glavni ustanovitelj Mednarodne podiplomske šole Jožefa Stefana, ki so se mu takoj pridružili štirje najmočnejši gospodarski soustanovitelji. Število teh se je v desetletnem delovanju MPŠ povečalo na dvajset. V MPŠ sta se vključila tudi Inštitut za kovinske materiale in tehnologije (IMT) in Nacionalni institut za biologijo (NIB).

Svet za visoko šolstvo RS je dal soglasje za ustanovitev MPŠ 3. decembra 2003, prva generacija študentov pa se je vpisala v študijskem letu 2004-2005. V letu 2014 je vpisanih prek 200 študentov, večina z visokimi ocenami dodiplomskega in podiplomskega študija. Do konca leta 2013 je na MPŠ zaključilo študij 210 študentov, število znanstvenih objav v revijah z visokim faktorjem vpliva je v povprečju na študenta od tri do pet. Njihovi mentorji so znanstveniki, ki se ponašajo z vrhunskimi domačimi in mednarodnimi priznanji. Ne nazadnje vsi dajejo priznanje tudi majhni, a izjemno učinkoviti strokovni službi.

Študijski programi MPŠ – Nanoznanosti in nanotehnologije, Ekotehnologija, Informacijske in komunikacijske tehnologije, v pripravi so še Senzorske tehnologije – združujejo najnovejše dosežke številnih ved in jih obenem ciljano usmerjajo v razvoj slovenske visokotehnološke ustvarjalnosti. So originalni in ne ponavljajo drugih visokošolskih programov.

Slovenija je v hudi gospodarski in moralni krizi in zapravlja tudi svoj intelektualni potencial. Mnogi odlični mladi raziskovalci odhajajo v tujino, saj doma zanje ni raziskovalnega in razvojnega dela, ker ni načrtnih vlaganj v možgane. Slovenska politika investicije v znanje zanemarja.

In vendar imajo zlasti mlade generacije vso pravico do dostojnega izhoda iz te krize, do novih delovnih mest, do napredovanja v domačem okolju. Znanje je glavna vrednota, ki omogoča narodu obstoj in razvoj. Mladi vrhunski raziskovalci, ki so pogoj zanj, pa so srce, ki poganja družbo znanja.

Jubilee of Research and Educational Creativity

In 2014, the Jožef Stefan International Postgraduate School (IPS) celebrates its tenth anniversary. However, if we also take into account the postgraduate theses written at the Jožef Stefan Institute (JSI) before that, then this year marks a 50 + 10 years jubilee!

The JSI, founded in 1949, is the largest Slovenian research institution and has an exceptional international reputation. The JSI has always paid special attention to the education of young researchers at leading research centres in the most developed countries, where they learned high-end research methods and techniques, and ways of scientific reflection.

Only the most qualified researchers can ensure excellent scientific achievements and their effective transfer into production processes and services. That is why the best JSI researchers became professors at the University of Ljubljana (UL), while the JSI enabled the best students of the UL to use the world-class research equipment of the institute. Until 2004, there were 692 doctoral dissertations, 808 master's theses and 2060 diplomas written at the JSI – a total of 3560, with the diplomas being awarded at the UL.

The JSI did not receive acknowledgment for this important cooperation and could not successfully realize its research and educational potential in inter/multi-disciplinary fields for which new scientific achievements offer the topmost basic knowledge and open up the possibilities for the development of high technologies. That is why in 1996 the JSI was the initiator and in 2003 the original founder of the Jožef Stefan International Postgraduate School. Four of the largest companies from industry immediately followed the institute's initiative. In the past 10 years the number of affiliated companies has risen to 20. The Institute of Metals and Technology and the National Institute of Biology also joined the IPS.

The Slovenian Council for Higher Education issued a consensus for the establishment of the IPS on 3 December 2003, and the first generation of postgraduate students enrolled in the academic year 2004/2005. In 2014, more than 200 students have enrolled, mostly with high grades from their under- and postgraduate studies. By the end of 2013, 210 postgraduates had completed their studies at the IPS. The number of scientific publications in journals with a high impact factor is on average from 3 to 5 per postgraduate student. Their supervisors are all acclaimed scientists, who gained recognition not only in Slovenia but also worldwide. Last but not least, it is important to recognise the small but extremely effective professional services of the school.

The IPS programmes – Nanosciences and Nanotechnologies, Ecotechnology, Information and Communication Technologies as well as Sensor Technologies (in preparation) – combine the newest achievements from numerous scientific fields and at the same time direct them towards the development of Slovenian high-technology creativity. They are unique and do not copy any other higher-education programmes.

Slovenia is suffering from a severe economic and moral crisis that is wasting its intellectual potential. Many excellent young researchers leave to work abroad, as there are no research and development opportunities for them in Slovenia due to the lack of planned investment in knowledge. Slovenian politics disregards investments in knowledge.

In particular, the younger generations have the right to overcome this crisis with dignity, to create new posts and to have the ability to progress in the local environment. Knowledge is the main value responsible for the existence and development of a nation. Excellent young researchers are the heart that is stimulating the knowledge-based society.

Prvi dekan MPŠ

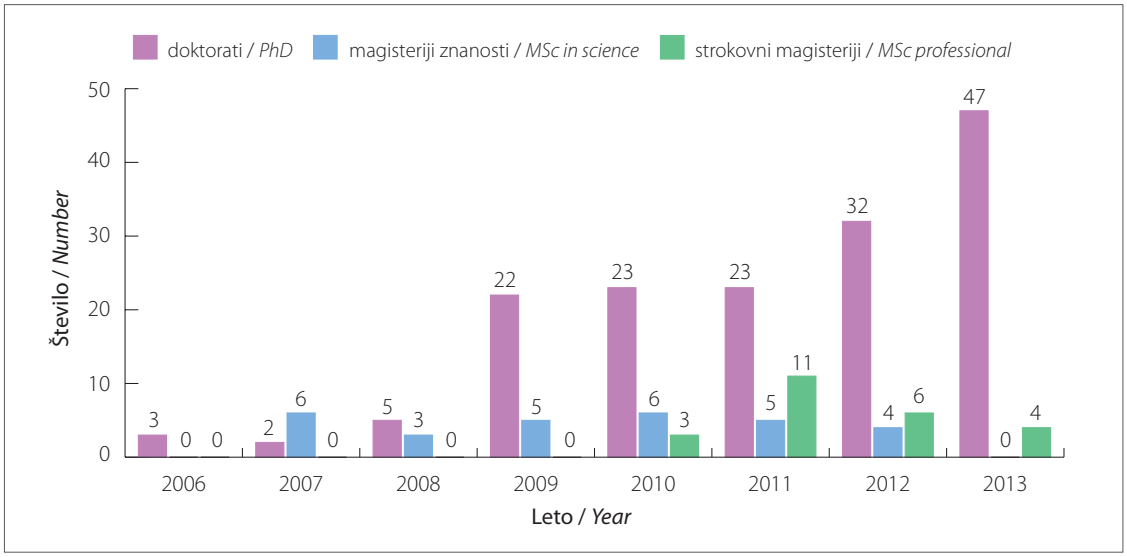
Prof. dr. Robert Blinc
(1933–2011)
Prvi dekan MPŠ
First IPS Dean

Akademik prof. dr. Robert Blinc je bil skupaj z akademikom prof. dr. Vitom Turkom nosilec ustanavljanja Mednarodne podiplomske šole Jožefa Stefana ter od prvega dne delovanja (2004) njen dekan. Vse do svoje smrti 26. septembra 2011 je snoval, spodbujal, organiziral in izvajal naloge za razvoj šole, ki se je v času njegovega vodenja povzpela do ravni vrhunske kakovosti.

Njegov osebni vzgled je bil promotor in garant vzpona. Imenovali so ga »velikan jedrske magnetne resonance in fizike trdne snovi«. Ne brez razloga: doma in po svetu je snoval in vodil raziskovalne laboratorije, odkrival mehanizme in razvijal modele zgradbe snovi, določal parametre procesov in sistemov ter razvijal NMR metode z velikim odmevom tudi v praksi. Objavil je več kot 700 izvirnih člankov, tudi v najbolj prestižnih znanstvenih revijah, z več kot 14.000 citati. Predaval je na svetovno vodilnih univerzah in konferencah, vodil vrsto izjemno zahtevnih projektov in predsedoval uglednim mednarodnim znanstvenim združenjem. Bil je član sedmih akademij znanosti, priznanj in nagrad za njegove vrhunske dosežke je na desetine. In predvsem: bil je izjemen učitelj in mentor mladim raziskovalcem, vzgojil je veliko uspešnih znanstvenikov.

Na Mednarodni podiplomski šoli Jožefa Stefana je bil in bo ostal med nami kot vzor: kot neumorni iskalec poti h kakovosti ob hkratnem širjenju obzorja, kot intelektualni nosilec trajnostnega razvoja, tudi kot zgled navdušenja in predanosti raziskovalnemu delu, kot promotor vključevanja znanstvenikov v razvojne projekte gospodarstva ter ne nazadnje kot skromen človek, ki je v vsem iskal bistvo ter odklanjal ohlapnost in hvalisanje.

Svoje enormno osebnostno bogastvo je v zadnjem desetletju svojega življenja v veliki meri podarjal Mednarodni podiplomski šoli Jožefa Stefana. To je naša zadolžnica, ki nas zavezuje v vsem delu. Zato Robert Blinc ni odšel – ostaja z nami kot vzgled in kot merilo, četudi ga bo zelo težko dosegati.



Doktorati in magisteriji na MPŠ v prvem desetletju, skupaj 210
PhD and MSc at IPS in the first decade, total 210

The First IPS Dean

Academician Professor Robert Blinc was, together with Academician Professor Vito Turk, the founder of the Jožef Stefan International Postgraduate School and the Dean from its establishment in 2004. Until his death on 26 September 2011, he planned, encouraged, organised and implemented the tasks for the development of the School, which rose to its current high level during the time of his management.

Professor Blinc was a promoter and guarantor of progress. He was known as a »giant of nuclear magnetic resonance and solid-state physics«, and not without foundation. At home and abroad he planned and managed research laboratories, discovered mechanisms and developed models of matter types, determined process and system parameters as well as developing NMR methods of great practical application. He published more than 700 original papers, including articles in the most prestigious scientific publications, with more than 14,000 citations. He gave lectures at the world's leading universities and conferences, led a number of extremely complex projects and presided over renowned international scientific associations. He was a member of seven academies of science and received great recognition and many prizes for his achievements. However, mostly, he was an outstanding teacher and supervisor to young researchers and produced many successful scientists.

At the Jožef Stefan International Postgraduate School he was, and will remain, a role model: as a tireless searcher of paths that lead to quality, while at the same time expanding horizons, as an intellectual bearer of sustainable development, as an example of enthusiasm and devotion to research work, as a promoter of the integration of scientists with industrial research projects and last, but not least, as a humble man who searched for the essence in everything and refused vagueness and vaunt.

He dedicated most of his enormous personal legacy to the Jožef Stefan International Postgraduate School in the last decade of his life. That is the promissory binding us in everything we do. This is why Robert Blinc did not leave – he remains with us as a role model and an example, even if it is hard to reach such high standards.

Pogled nazaj za pot naprej

Prof. dr. Aleksandra Kornhauser-Frazer
Dekanja MPŠ
IPS Dean

Jubileji so največkrat le iskre, ki popestrijo kak dan. Večji pomen pridobijo, če se ob njih zamislimo po starem reku: življenje živimo s pogledom naprej, razumemo pa ga šele s pogledom nazaj.

Kaj je tisto najbolj pomembno, kar bi lahko s pogledom v preteklo desetletje bolje razumeli? Zagotovo je to trajnostni razvoj. Še pred desetimi leti je bil predvsem tema znanstvenih razprav in oznanilo majhnih skupin navdušencev, ki so klicali k streznitvi. Trajnostni razvoj danes je najširše razumljen kot osnovni pogoj za preživetje in na vseh ravneh sprejet kot neogibna obveznost.

Kljub temu je njegova načela zelo težko uresničevati, saj terjajo omejevanje dobrin. Bogatejši se nočejo odrekati visoke življenjske ravni, revni pa utemeljeno zahtevajo pravico do boljšega življenja. Zato lahko trajnostni razvoj uresničimo le tako, da bomo imeli manj, a tisto bo bistveno boljše. V ospredje torej stopa kakovost – proizvodov, storitev, odnosov.

Narediti bistveno boljše proizvode iz manjše količine enakih ali celo slabših surovin, ob manjši porabi virov energije in to z okolju prijaznimi tehnologijami, terja najprej znanje, veliko več znanja, kot ga imamo. Pa visoke tehnologije in visoko usposobljene kadre. To zagotavljata le raziskovalna in izobraževalna dejavnost najvišje možne kakovosti.

Prav temu se je zapisala MPŠ tudi v naslednjem desetletju. Snovala in izvajala bo predvsem tiste programe, ki temeljijo na visoko propulzivnih raziskavah in v ciljanem razvoju prepletajo celo vrsto disciplin. Vanje bo vključevala raziskovalce, ki delajo v jedru teh raziskav. Prednostno bo pritegovala tiste mlade ljudi, ki so jim razvojne potrebe osebni izziv in težijo k ustvarjalnosti kot svoji ključni življenjski potrebi. Navezovala se bo na tiste raziskovalne in izobraževalne institucije ter na podjetja v industriji in storitvenih dejavnostih, ki jim bo kakovost le drugo ime za trajnostni razvoj.

Uresničevanje trajnostnega razvoja terja modrost. Ta je kombinacija znanja in vrednot, ki jih ustvarja kultura. Zato bo MPŠ v prihodnje še bolj kot doslej skrbela za tiste vrednote, ki jih znanost prispeva v kulturno zakladnico. Načrtno bo skrbela za uresničevanje znanstvenih kriterijev kakovosti ustvarjanja in prenosa znanstvenih dosežkov , ne le v svetovno zakladnico znanja, tudi v delo in odločanje. Skrbela bo za razvoj sposobnosti za ustvarjalno skupinsko delo, kritičnost v opredeljevanju dosežkov in poštenost v njihovih predstavitvah. Zavedala se bo svoje soodgovornosti za odpiranje visoko zahtevnih delovnih mest, posebej za ustvarjalne možnosti mladih raziskovalcev. Gojila bo znanstveno miselnost za spodbujanje najširše ustvarjalnosti, strpnosti, sodelovanja. Poudarjala bo pripadnost svoji kulturi in odprtost za sodelovanje prek meja ter spoštovanje različnosti.

V ta namen bo tudi gojila jezik za razumevanje znanstvenih dosežkov v najširših plasteh prebivalstva in temeljito obvladovanje svetovnega jezika, da bi magistri in doktorji MPŠ z globokimi koreninami doma lahko suvereno stopali tudi v svetovno areno.

Kdo ve ali bomo te ambiciozne načrte uresničili? Zagotovo pa vemo, da bo ob naslednjem jubileju MPŠ spet treba pogledati nazaj in ugotoviti, katere zaobljube so bile uresničene, kajti le tako bomo lahko začrtali varno pot naprej.

Looking back to go ahead

Jubilees are most often merely sparks that bring light to a day. However, their importance grows if we ponder the old saying: we live life by always looking ahead, but we can fully understand it only by looking back.

What is the most important thing we could understand better by looking back over the past ten years? Most certainly this is sustainable development. Only ten years ago, sustainable development was mainly a subject of scientific discussions and a declaration of small groups of enthusiasts calling for the awareness of the danger. Today, sustainable development is widely understood as a basic condition for survival and accepted as an unavoidable responsibility at all levels.

Nevertheless, the principles of sustainable development are hard to fulfil, as they demand a restriction of goods. Those who are better off refuse to give up their high living standards, while those who are less fortunate demand the right to a better life, and rightly so. Therefore, sustainable development can only be realised by us having less, but of significantly better quality. The quality of products, services and relations is consequently coming to the fore.

Creating significantly better products from smaller amounts of the same or even inferior materials and with a reduced energy consumption and environment-friendly technologies demands knowledge in the first place, plenty more than we already have, as well as high technologies and highly qualified staff, which can only be assured by research and education of the highest quality.

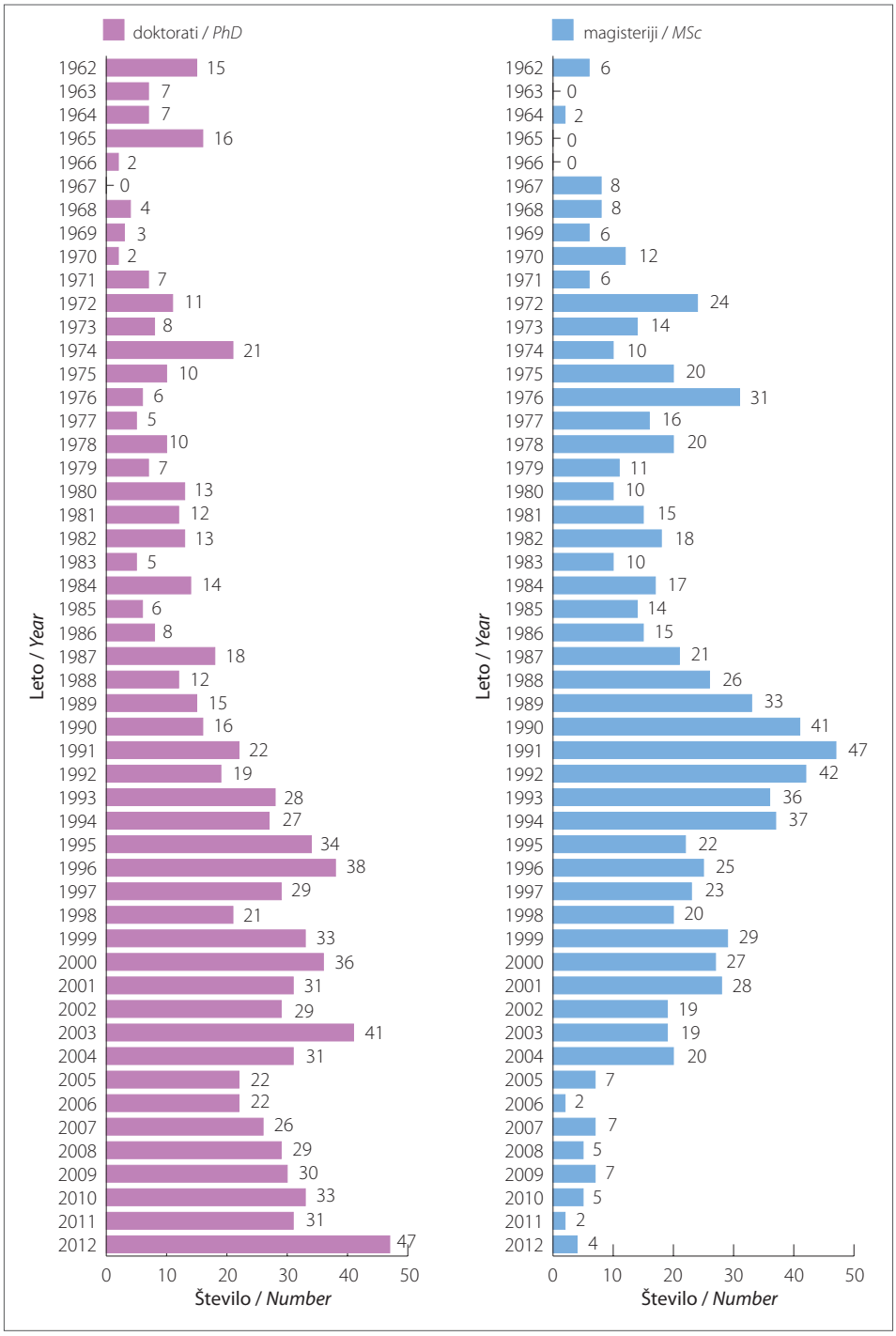
This is precisely what the IPS will strive to achieve over the next ten years. The school will design and carry out those programmes that are based on highly driven research and that intertwine a wide range of disciplines. In its programmes, it will include researchers who work at the very core of research. It will primarily attract those young candidates who take development needs as a personal challenge and who strive for creativity as a life necessity. The school will lean on those research and education institutions as well as the companies from the industry and service activities who consider quality as a synonym for sustainable development.

The integration of sustainable development demands wisdom that is a combination of the knowledge and values created by culture. The IPS will therefore continue, even more so in the future, to take care of the values that science contributes to the world treasury of culture. It will systematically take care of the implementation of scientific criteria of the quality in the creation and transfer of research achievements, not only to the world treasury of knowledge, but also to work and decision-making processes. It will strive to develop the capability of creative teamwork, a critical approach in defining achievements, and honesty in their presentation. It will be aware of its co-responsibility for opening highly qualified employment opportunities, especially for the creative possibilities of young researchers. It will cultivate a scientific mind-set for encouraging creativity, tolerance and collaboration to the greatest possible extent. It will emphasise its affiliation to its own culture and readiness to collaborate across borders, as well as a respect for diversity. For this purpose, the IPS will cultivate a language that will enable an understanding of scientific achievements in the broadest population, as well as strive for a thorough mastering of the global language that will support the masters and doctors of the IPS to develop strong roots at home and to enter the world arena without fear.

Who knows if we are going to be able to achieve these goals? However, we know for certain that it will be necessary to look back again at the time of the next IPS jubilee and to check which of the pledges have been fulfilled. Only by doing so, we will be able to outline a secure path into the future.

IJS – pol stoletja podiplomskega raziskovanja

JSI – Half a century of postgraduate research



Opravljena doktorska in magistrska dela na IJS do 2012

Completed doctoral and master theses at JSI till 2012

Slavnostna otvoritev MPŠ 25. maja 2004

IPS Opening ceremony, 25th May 2004

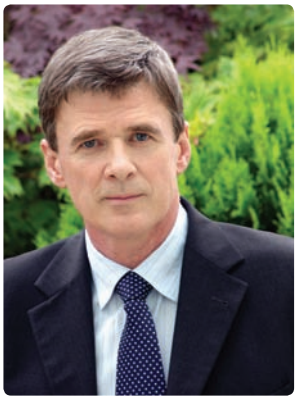
Predsednik MPŠ, tedaj direktor IJS prof. dr. Vito Turk (desno) in minister za visoko šolstvo, znanost in tehnologijo dr. Slavko Gaber (levo) otvarjata prostore MPŠ.

IPS President, then JSI Director Professor Vito Turk (right) and Minister for Higher Education, Science and Technology Dr. Slavko Gaber (left) opening IPS premises.

Slavnostna otvoritev MPŠ, od leve: prvi dekan prof. dr. Robert Blinc, minister dr. Slavko Gaber, predsednik MPŠ prof. dr. Vito Turk, predstavnik EU, DG XII-Znanost, raziskovanje in razvoj dr. Giancarlo Caratti in in tedaj prodekanja MPŠ prof. dr. Aleksandra Kornhauser-Frazer

IPS Opening ceremony, from left: first IPS Dean Professor Robert Blinc, Minister Dr. Slavko Gaber, IPS President Professor Vito Turk, EU Representative, DG XII-Science, Research and Development Dr. Giancarlo Caratti and then IPS Vice-Dean Professor Aleksandra Kornhauser-Frazer

Ustanovni in pridruženi partnerji MPŠ



Prof. dr. Jadran Lenarčič
Direktor IJS
Director, JSI

Glavni ustanovitelj MPŠ: Institut »Jožef Stefan«

Mednarodna podiplomska šola Jožefa Stefana je v mnogočem edinstvena podiplomska izobraževalna ustanova v slovenskem prostoru. Primerljivo težko najdemo v bližnji okolici. Zasnovali so jo Institut »Jožef Stefan« in njegovi najbližji gospodarski partnerji Gorenje, Kolektor, Salonit in Slovensko zavarovalno združenje zlasti zaradi potrebe po prenašanju vrhunskih raziskovalnih dosežkov v industrijsko prakso. Kot soustanovitelji so se kasneje pridružile tudi druge znanstvene in gospodarske organizacije, ki so pomembno prispevale k njenemu nastajanju in razvoju.

Posebnost šole sta razpetost med vrhunskim znanstvenim raziskovanjem in gospodarskim razvojem ter veliko število mednarodnih študentov, ki izvajajo raziskovalno delo v odličnih laboratorijih Instituta »Jožef Stefan« in drugih pridruženih organizacij. Študentje imajo zaradi tega na razpolago kakovostno raziskovalno opremo, odlične mentorje in druge strokovnjake ter se srečujejo z mladimi raziskovalci z vsega sveta, s katerimi lahko izmenjujejo izkušnje, znanje, zamisli in motivacije. Takšno večkulturno okolje spodbuja ustvarjalnost ter navdihuje vsakogar, ki v njem deluje. Na Mednarodni podiplomski šoli sodelujejo tudi vrhunski profesorji iz tujine.

Institut »Jožef Stefan« vidi v Mednarodni podiplomski šoli pomembnega partnerja in z njeno pomočjo širi možnosti svojega sodelovanja v projektih za gospodarstvo ter drugih domačih in mednarodnih projektih. S pomočjo šole se na Institutu izobražuje mnogo mladih raziskovalcev, ki nadaljujejo svojo kariero na Institutu, v industriji ali v drugih organizacijah in s tem ustvarjajo mostove bodočim znanstvenim in razvojnim projektom. Razume se, da Mednarodna podiplomska šola ne bi mogla obstajati in se razvijati brez zaledja Instituta »Jožef Stefan«, po desetih letih njenega delovanja pa lahko zatrdim, da tudi Institut ne bi bil tako uspešna ustanova, če ne bi bilo Mednarodne podiplomske šole. V sodelovanju z Mednarodno podiplomsko šolo postaja Institut »Jožef Stefan« pomembno srednjeevropsko znanstveno, raziskovalno-izobraževalno in tehnološko središče.

Jadran Lenarčič
Direktor, Institut »Jožef Stefan«

IPS Founding and Associate Partners

Principal founder of the IPS: Jožef Stefan Institute – JSI

The Jožef Stefan International Postgraduate School is, in many ways, a unique educational institution in the Slovenian region. There are, for example, no comparable organizations nearby. The School was created by the Jožef Stefan Institute and its close economic partners, Gorenje, Kolektor, Salonit and the Slovensko zavarovalno združenje, with the primary aim of the better transfer of cutting-edge research achievements into industrial practice. Since then, other scientific and industrial organizations have joined and also made significant contributions to its continued development.

The main speciality of the School is the intersection of top-level scientific research and industrial development. The School involves a large number of international students who carry out their research work in the excellent laboratories of the Jožef Stefan Institute and other associated organizations. This means that the students have available high-quality research equipment, supervisors of the highest calibre and other professionals, and have the opportunity to meet with young researchers from around the world, with whom they can share their experience, knowledge, ideas and motivations. Such a multicultural environment encourages creativity and inspires everyone who works in it. Renowned foreign professors are also involved with the School.

The Jožef Stefan Institute sees the International Postgraduate School as an important partner and, with its help, will expand opportunities to collaborate in various domestic and international R&D projects. With the help of the School, the Institute educates many young researchers to continue their careers at the Institute, in industry or in other organizations, and thus create bridges for future scientific and development collaborations. It is understood that the International Postgraduate School could not operate without the support of the Jožef Stefan Institute, but after 10 years of its existence I can also say that the Institute would not have been so successful without the School. In collaboration with the Jožef Stefan International Postgraduate School the Institute is becoming an increasingly important Central European scientific, research-educational and technological centre.

Jadran Lenarčič
Director, Jožef Stefan Institute

Institut »Jožef Stefan« (IJS) je največje raziskovalno središče v Sloveniji, ki pokriva široki spekter področij temeljnega in uporabnega raziskovanja in zaposluje več kot 960 sodelavcev. Poslanstvo Instituta je v ustvarjanju, širjenju in prenosu znanja na področju naravoslovnih in tehniških znanosti ter znanosti o življenju. Institut izvaja vrhunske raziskave in razvoj tehnologij, kot so nanotehnologije, novi materiali, biotehnologije, tehnologije vodenja in proizvodnje, komunikacijske tehnologije, računalniške tehnologije in tehnologije znanja, okoljske tehnologije in reaktorske tehnologije.

Institut je mednarodno visoko priznana znanstvena ustanova in neposredno sodeluje z mnogimi uglednimi institucijami po svetu. Glede na število evropskih projektov je Institut uvrščen na sam evropski vrh. Ob tem načrtno skrbi za mednarodno izmenjavo strokovnjakov. Institut zagotavlja domačim in gostujočim raziskovalcem ter študentom tudi vrhunsko raziskovalno opremo.

Institut »Jožef Stefan« intenzivno sodeluje pri spodbujanju gospodarskega in socialnega razvoja, zlasti na področju visokih tehnologij. Njegova ustvarjalnost bistveno prispeva k šolanju raziskovalcev in razvojnih strokovnjakov, tudi v sklopu izvajanja razvojnih raziskav, ki so neposredno navezane na uporabnike. Ustvarjeno novo znanje skušajo raziskovalci Instituta razviti do stopnje za neposredno uporabo in prenesti v gospodarstvo za reševanje mnogih zapletenih razvojnih problemov.

Institut »Jožef Stefan« je edini multidisciplinarni raziskovalni center v Sloveniji. Na Institutu deluje 28 raziskovalnih odsekov, ki pokrivajo naslednja raziskovalna področja: teoretična fizika, fizika nizkih in srednjih energij, tanke plasti in površine, tehnologija površin in optoelektronika, fizika trdne snovi, kompleksne snovi, reaktorska fizika, eksperimentalna fizika osnovnih delcev, biokemija, molekularna in strukturna biologija, molekularne in biomedicinske znanosti, biotehnologija, anorganska kemija in tehnologija, fizikalna in organska kemija, elektronska keramika, inženirska keramika, nanostrukturni materiali, sinteza materialov, raziskave sodobnih materialov, znanosti o okolju, avtomatika, biokibernetika in robotika, sistemi in vodenje, umetna inteligenca, odprti sistemi in mreže, komunikacijski sistemi, računalniški sistemi, tehnologije znanja, Inteligentni sistemi ter reaktorska tehnika. Ob tem si Institut prizadeva za intenzivno multidisciplinarno sodelovanje med odseki, zlasti v povezavi z domačimi in mednarodnimi raziskovalnimi in razvojnimi projekti. To povezovanje podpira širšo ustvarjalnost tudi v sklopu podiplomskega študija.

***The Jožef Stefan Institute (JSI) is the largest research center in Slovenia**, covering a wide range of areas of basic and applied research, and employs more than 960 employees. The mission of the Institute is the creation, dissemination and transfer of knowledge in the field of natural and technical sciences and life sciences. The Institute carries out cutting-edge research and the development of technologies such as nanotechnology, new materials, biotechnology, technology management and production, communication technology, computer technology and knowledge technology, environmental technology and reactor technology.*

The Institute is ranked among the top European research institutions and is directly involved with many important institutions around the world. Based on the number of European projects, the Institute is ranked at the highest level in Europe. The Institute implements actions to carry out the international exchange of experts and provides local and visiting researchers and students with excellent research facilities.

The Jožef Stefan Institute is actively engaged in promoting economic and social development, particularly in the field of high technologies. It contributes to the education of researchers and development experts, also in the context of the implementation of its scientific achievements in practice. The researchers are committed to the transfer the new knowledge in industry in order to solve many complex development problems.

The Jožef Stefan Institute is the only multi-disciplinary research center in Slovenia. The Institute operates in 28 research departments, covering the following research areas: theoretical physics, low- and medium-energy physics, thin films and surfaces, surface engineering and optoelectronics, condensed matter physics, complex matter, reactor physics, experimental particle physics, biochemistry and molecular biology, molecular and biomedical sciences, biotechnology, inorganic chemistry and technology, physical and organic chemistry, electronic ceramics, engineering ceramics, nanostructured materials, synthesis of materials, advanced materials, environmental sciences, automation, biocybernetics and robotics, systems and control, artificial intelligence, open computer systems and networks, communication systems, computer systems, knowledge technologies, intelligent systems, and reactor engineering.

Optične komponente v laboratorijskem kozmološkem eksperimentu

Optical components in a laboratory cosmological experiment

Pridruženi inštituti

IMT, Inštitut za kovinske materiale in tehnologije

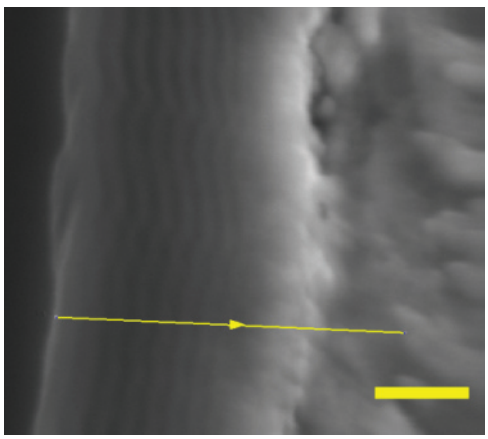
Prof. dr. Monika Jenko

Direktor IMT od 2000 do 2011

IMT Director from 2000 till 2011

IMT, Inštitut za kovinske materiale in tehnologije, je vodilna raziskovalna ustanova na tem področju v slovenskem prostoru; zaposluje 40 raziskovalcev. Inštitut izvaja temeljne in aplikativne raziskave zlitin na osnovi železa, jekel ter sorodnih materialov, vključno intermetalnih zlitin, kompozitov, nanomaterialov, barvnih kovin – predvsem aluminija – ter raziskave in razvoj na področjih visoko tehnološke metalurgije kot tudi vakuumske tehnike, metrologije ter modeliranja strjevanja in mikrostrukture. Poleg tega raziskuje na področjih nuklearne in termo-energetike, gradbeništva in kovinsko predelovalne ter elektro industrije. Dosežke prispeva v svetovno zakladnico znanja in posebej skrbi za uporabo znanja v industriji v Sloveniji in tujini s poudarkom na čistih tehnologijah.

Inštitut se je pridružil MPŠ kot partner v letu 2006. V podiplomski študij na MPŠ je usmeril 16 študentov, med njimi 9 iz tujine. Do konca 2013 je izmed njih zaključilo podiplomski študij 6 doktorjev znanosti ter 2 strokovna magistra.



SE posnetek prereza večplastne trde prevleke TiN/Ti(B-N)/TiB2/ prikazuje mesto AES linijske analize.

SE image of a section of a multilayer TiN/Ti(B-N)/TiB2/ hard coating shows the AES line analysis spot.

Associate Institutes

IMT – Institute of Metals and Technology

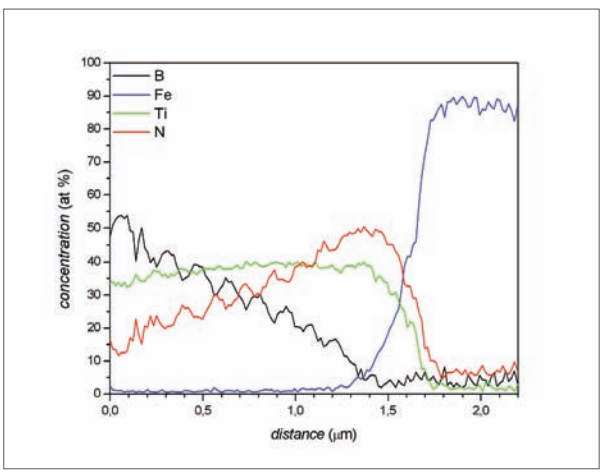
Dr. Matjaž Godec

Direktor IMT od 2011

IMT Director since 2011

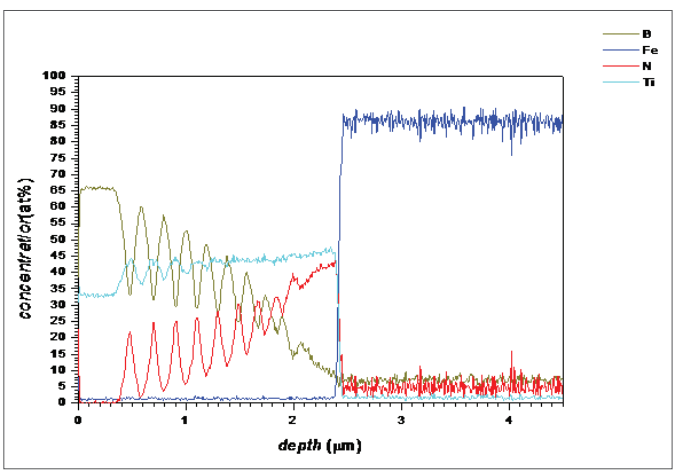
The Institute of Metals and Technology (IMT), with its 40 researchers, is a leading research institute for this particular scientific field in Slovenia. The institute carries out basic and applied research on alloys of iron, steel and other similar materials, including intermetallic alloys, composites, nanomaterials, non-ferrous metals – especially aluminium – as well as R&D in the field of high-technology metallurgy, vacuum engineering, metrology and the modelling of solidification and microstructure. The institute also carries out research in the field of nuclear and thermal energetics, civil engineering, iron processing and the electro industry. The research results contribute to world knowledge and the transfer of this knowledge to industry in Slovenia, with the emphasis being on clean technologies.

The institute joined the IPS as a partner in 2006. It has encouraged 16 students to pursue postgraduate studies, of which 9 students came from abroad. By the end of 2013, 6 doctors and 2 masters had completed their postgraduate studies at the IPS.



Koncentracija Ti, N, B in Fe izračunana iz AES linijske analize vzdolž linije

Ti, N, B and Fe concentration calculated from the AES line analysis along the line



AES globinski profil TiB_2/Ti(N-B)/TiN večplastne trde prevleke

AES depth profile of a TiB_2/Ti(N-B)/TiN multilayer hard coating

NIB – Nacionalni inštitut za biologijo

Prof. dr. Tamara Lah Turnšek

Direktorica NIB

»Znanje in spoznanje sta dvorezen meč, vendar edino, kar nas razlikuje od drugih živih bitij.«

NIB je vodilni nacionalni inštitut na področju biologije, ki zaposluje okoli 120 raziskovalcev, med njimi več kot 20 doktorandov – mladih raziskovalcev. Usmerjen je v raziskovanje morja, sladkovodnih in kopenskih ekosistemov, entomologijo ter fiziologijo in bolezni rastlin. Na molekularnem nivoju deluje na področju analize genetsko spremenjenih rastlin in virusih okužb, genetske toksikologije in karcinogeneze. Pri tem raziskovalci uporabljajo orodja sistemske biologije, ki posega tudi na določena področja biotehnologije. Ključna usmeritev delovanja v vseh teh znanstvenih vejah je odličnost v temeljnih raziskavah, ki zagotavlja osnove za prenos dosežkov v uporabne rešitve, zlasti na področjih okolja, voda, varne hrane in varstva rastlin. Pri tem se NIB povezuje s farmacevtsko, biotehnološko in prehrambeno industrijo. NIB se je pridružil kot partner MPŠ v letu 2013. Sodeluje pri snovanju in izvajanju vseh študijskih programov ter še posebej pri zasnovi novega študijskega programa *Senzorske tehnologije* kot nosilec vodilne ekspertize na področju biosenzorjev.

Nacionalni inštitut za biologijo, Ljubljana

National Institute of Biology, Ljubljana

NIB – National Institute of Biology

Prof. Dr. Tamara Lah Turnšek
NIB Director

> *»Knowledge and understanding are a double-edged sword, but the only thing that sets us apart from other living beings.«*

The National Institute of Biology (NIB) is the leading national institute in the field of biology. It employs about 120 researchers, of which more than 20 are PhD students – young researchers. It is oriented towards marine research, freshwater and terrestrial ecosystems, entomology, as well as plant physiology and diseases. On a molecular level, the Institute carries out research in the field of the analysis of genetically modified plants and virus infections, genetic toxicology and carcinogenesis. For this the researchers use the tools of systems biology, which also falls within some of the fields of biotechnology. The key to research in all these scientific fields is the striving for excellence in basic research, which enables the transfer of results to useful solutions, especially in the field of environment, water, food safety and the protection of plants. For this purpose the NIB collaborates with the pharmaceutical, biotechnical and food industries. The NIB joined the IPS as a partner in 2013. It cooperates in designing and implementing all the study programmes, especially the new study programme entitled Sensor Technologies, as it is a leading expert in the field of biosensors.

Morska biološka postaja, Piran
Marine Biology Station, Piran

Gospodarski soustanovitelji MPŠ

Gospodarske organizacije so bistveni usmerjevalci programov MPŠ, zlasti v:
- snovanju, organiziranju in izvajanju raziskovalno-izobraževalnih programov in projektov,
- umeščanju tem magistrskih in doktorskih del v razvojne projekte gospodarstva,
- pridobivanju in usmerjanju mladih raziskovalcev iz gospodarstva,
- neposrednem informiranju vseh študentov MPŠ o razvojnih ciljih in programih gospodarstva.

V izvajanju študija MPŠ zagotavlja možnosti za doseganje visoke kakovosti znanstvenega raziskovanja in neposredne uporabnosti za ciljani gospodarski razvoj.

Ob ustanovitelju MPŠ – Inštitutu »Jožef Stefan« – so štirje soustanovitelji MPŠ.

gorenjegroup

Franjo Bobinac

Predsednik uprave Gorenje d.d.

»Končni potrošnik, ki kupuje izdelke za dom, ima danes neverjetno izbiro – samo izdelki, v katerih je vgrajeno dovolj znanja in inovativnih rešitev, lahko zmagujejo na trgu.«

Gorenje, največje slovensko industrijsko podjetje z več kot šestdesetletno tradicijo v razvoju in proizvodnji aparatov za dom, je v zadnjih letih postalo tudi ena vodilnih evropskih multinacionalk na svojem področju, ki posluje v več kot 90 državah na vseh kontinentih. Zaposluje blizu enajst tisoč sodelavcev.

Razvoj proizvodov in storitev vključuje raziskave za večanje učinkovitosti in ekološke sprejemljivosti tehnologij, zlasti inovativnih hladilnih tehnologij, avtomatizacijo proizvodnje in optimizacijo funkcij proizvodov, višanje kakovosti in učinkovitosti proizvodov s senzorskimi tehnologijami ter obvladovanje celotnega življenjskega ciklusa vsakega proizvoda. Poseben poudarek je na funkcionalnosti proizvodov in estetiki dizajna.

IPS Economic Cofounders

Industrial organisations are of key importance for the IPS programmes, especially for:

- *designing, organising and executing research-educational programmes and projects,*
- *implementing the topics of master theses and doctoral dissertations into research projects for industry,*
- *acquiring and directing young researchers from industry,*
- *directly informing all IPS postgraduate students of the development objectives and programmes of industry.*

Studies at the IPS make it possible to achieve high-quality scientific research with direct relevance for economic development.
In addition to the founder of the IPS – the Jožef Stefan Institute – the IPS has four cofounders.

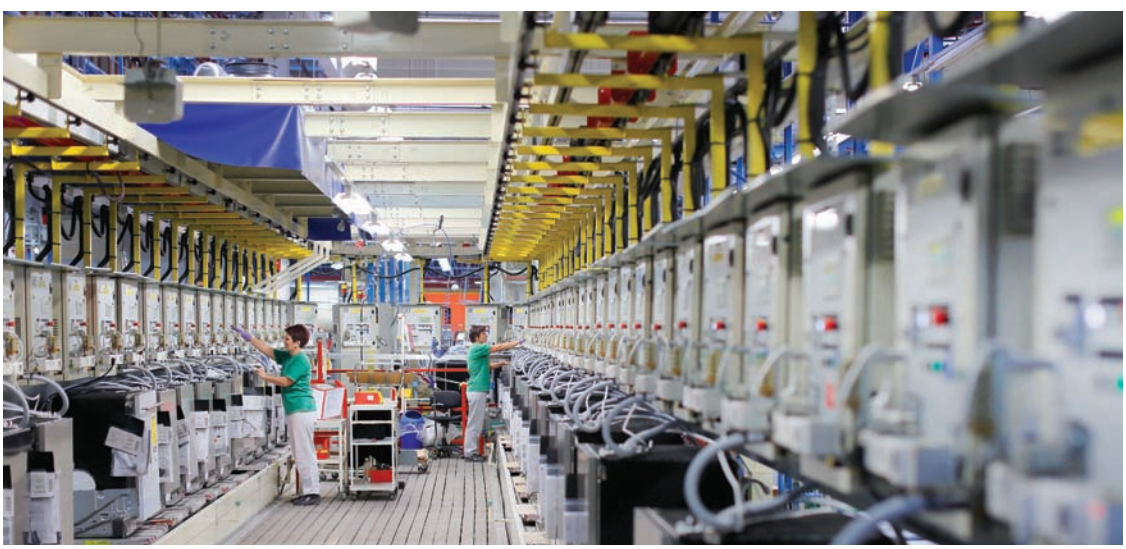
Franjo Bobinac

President and CEO Gorenje

> *»The consumer who buys domestic products nowadays has a wide selection to choose from – but only products with integrated knowledge into innovative solutions can prevail in the market.«*

Gorenje, the largest Slovenian industrial company, with more than 60 years of tradition in developing and producing home appliances, also became one of the leading European multinational corporations in the past few years, with units in more than 90 countries and on every continent. The company has close to 11,000 employees.

The development of products and services includes research in order to increase the efficiency and environmental acceptability of technologies, in particular innovative technologies in cooling devices, the automation of production and the optimisation of product functions, improving the quality and efficiency of products with sensor technologies and controlling the entire life cycle of each product. Special emphasis is put on the functionality of products and the aesthetics of the design.



Kontrola v proizvodnji pomivalnih strojev

Dishwasher production control

KOLEKTOR

Radovan Bolko

Glavni izvršni direktor

»Poganjamo prihodnost. Pogonsko sredstvo za to je znanje.«

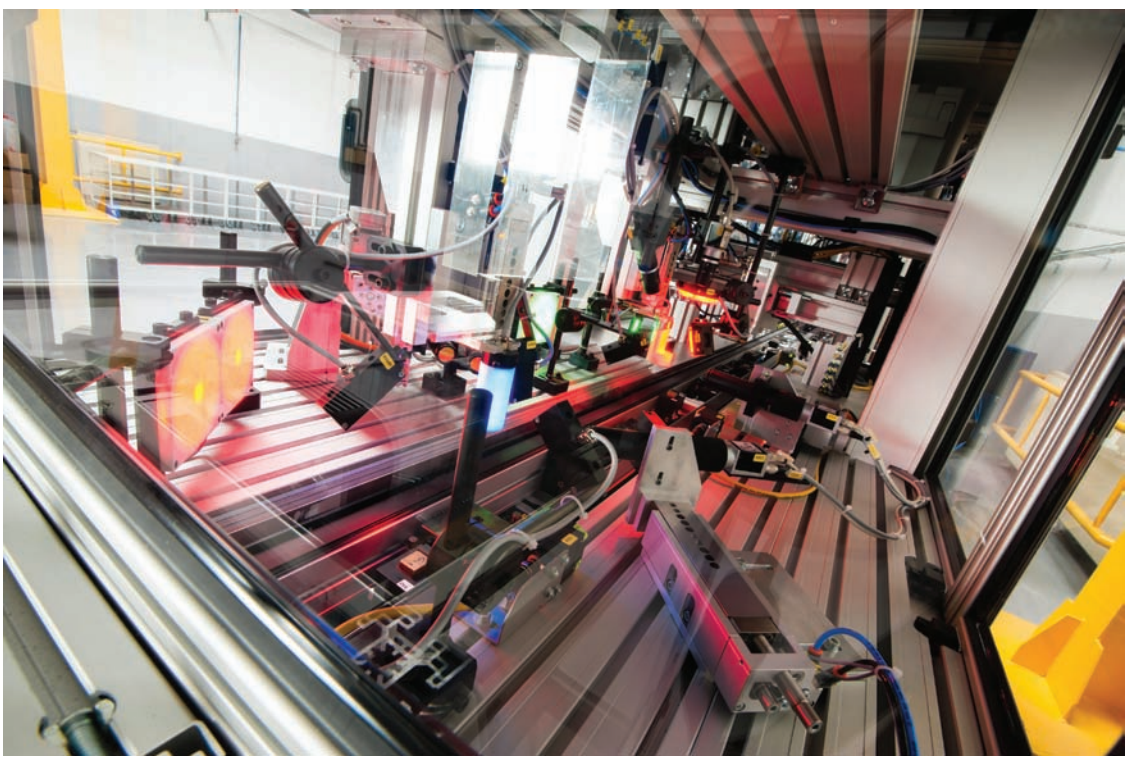
Kolektor je v pol stoletja delovanja postal multinacionalka s transnacionalno miselnostjo, ki na strateških trgih Evrope, Amerike in Azije povezuje blizu 30 podjetij in zaposluje tri tisoč sodelavcev. Dejavnost Kolektorja temelji na treh stebrih: komponentah in sistemih, stavbni tehniki in izdelkih za dom ter energetiki in industrijski tehniki. Inovacije, vlaganja v vrhunsko tehnologijo, sistem vodenja kakovosti in predvsem visoko usposobljeni zaposleni so gonilo Kolektorjevega napredka. Podjetje načrtno skrbi za večanje obsega in kakovosti intelektualne lastnine (ima več kot 50 patentov) ter goji množično inovativnost, pri kateri sodelujejo vsi zaposleni. Razvojne raziskave potekajo na področjih barvastih kovin in specialnih zlitin in njihovih uporab, polimerov in njihove predelave, mehko in trdomagnetnih materialov, kompozitov, nanomaterialov, tehnologij spajanja kovinskih in polimernih materialov, elektromotorskih pogonov, vodnih turbin in črpalk ter energetskih transformatorjev. Kolektor usmerja svojo dejavnost v skladu z načeli trajnostnega razvoja in v ta namen izvaja raziskave ter uvaja inovacije zlasti na področjih avtomobilske industrije (zmanjšanje porabe goriv in znižanje izpustov) in pri izrabi obnovljivih virov energije – OVE (projekti s področja hidroenergetike in učinkovite rabe energije pri pametnih zgradbah). Pri vzgoji sodelavcev, še posebej za zahtevne razvojne naloge, Kolektor sodeluje z raziskovalnimi in visokošolskimi institucijami.

Radovan Bolko

CEO, Kolektor

»We are propelling the future. The driving force is knowledge.«

After 50 years of operation, Kolektor has become a multinational company with transnational mode of thinking, uniting close to 30 smaller companies at the strategic markets of Europe, America and Asia. The company has 3000 employees and focuses on three main fields: components and systems, building technology and home products, and energy and industrial technology. Innovations, investments in high technology, a system of quality management and, in particular, highly qualified staff are the driving forces behind the company's success. The company systematically increases the scope and quality of its intellectual property (with more than 50 patents) and cultivates mass innovation with the help of the entire staff. Development research is carried out in the fields of non-ferrous metals, special alloys and their applications, polymers and their treatment, magnetically soft and hard materials, composites, nanomaterials, technologies for joining metals and polymers, electric motors, water turbines and pumps, and power transformers. Kolektor operates in accordance with the principles of sustainable development and to this end performs research and introduces innovation, especially in the fields of the automobile industry (reducing fuel consumption and emissions) and the consumption of renewable energy sources (projects in the fields of hydroenergetics and efficient energy consumption in smart buildings). In educating its employees, especially for the most demanding development tasks, the company collaborates with research and higher-education institutions.



Optična kontrola izdelkov

Optical inspection of products

SALONIT ANHOVO, gradbeni materiali, d.d.

Julijan Fortunat, predsednik uprave (levo)
dr. Tomaž Vuk, član uprave (desno)

»Sodobna družba se sooča s številnimi izzivi in si bo le s pravočasno pripravo nanje zagotovila trajnostni razvoj. Pri tem bodo zelo pomembna tudi nova znanja, pridobljena v sodelovanju z akademsko sfero.«

Salonit Anhovo je vodilni proizvajalec gradbenih proizvodov v Sloveniji s skoraj stoletno tradicijo proizvodnje cementnih in drugih hidravličnih veziv. Ponaša se z najsodobnejšo okoljsko in tehnološko razvito proizvodno linijo. V skupini Salonit je zaposlenih 470 sodelavcev. Razvoj skupine pokriva področja cementnih in drugih hidravličnih veziv, agregatov, mineralnih surovin, betonov ter drugih gradbenih proizvodov na cementni osnovi. Posebna skrb je namenjena razvoju čistejših tehnologij, zmanjševanju porabe energije iz neobnovljivih virov, varovanju okolja in razvoju okolju prijaznih proizvodov. Ključna usmeritev podjetja je uspešno in učinkovito šolanje mladih specialistov in visoko izobraženih sodelavcev z namenom pridobitve novih tehničnih znanj.

Julijan Fortunat, *President of the Managing Board (on the left)*
Dr. Tomaž Vuk, *Member of the Managing Board (on the right)*

> *»Modern society is facing numerous challenges and only timely preparation to solve them can ensure sustainable development. New knowledge, acquired in collaboration with the academic sphere, will thus be of great importance.«*

Salonit Anhovo is the leading manufacturer of construction products in Slovenia, with almost 100 years of tradition in the production of cement and other hydraulic binders. The company boasts an environmentally and technologically advanced production line. The Salonit Group has 470 employees and covers the fields of cement and other hydraulic binders, aggregates, mineral raw materials, concrete and other construction products based on cement. Special care is dedicated to the development of cleaner technologies, the reduction of the use of non-renewable sources of energy, environment protection and the development of environmentally friendly products. A key aim of the company is to successfully and efficiently educate its young experts and its highly educated employees in order for them to acquire new technical knowledge.

Proizvodnja v Salonitu
Production in Salonit

Slovensko zavarovalno združenje G.i.z. – SZZ

Mag. Mirko Kaluža

Direktor SZZ od 1997 do 2013

Predsednik Skupščine MPŠ

»Samo visoko izobraženi in usposobljeni strokovnjaki lahko odpirajo vrata razvoju in napredku družbe.«

Drago Cotar

Direktor SZZ od 2013

»Znanje je prihodnost.«

Slovensko zavarovalno združenje je gospodarsko interesno združenje slovenskih zavarovalnic in pozavarovalnic. Deluje od leta 1992 in povezuje 21 slovenskih zavarovalnih družb v skupnih naporih za večanje pomena in učinkovitosti zavarovalnih poslov: rešuje odškodninske zahtevke za mednarodne avtomobilske škode, vodi škodni sklad, odškodninski urad in informacijski center, vodi zavarovalniško statistiko in izdaja Statistični bilten, organizira izobraževanje za pridobitev licence za zavarovalne zastopnike in posrednike ter druge specializirane oblike izobraževanja. Združenje je včlanjeno v vse pomembne mednarodne zavarovalniške organizacije, katerih cilj je napredek zavarovalne dejavnosti. Razvoj je usmerjen v dvig strokovnega znanja zaposlenih in osveščanje prebivalstva o pomenu zavarovalništva za posameznika in družbo.

Slovenian Insurance Association – SZZ

Mirko Kaluža, MSc

Director SZZ from 1997 till 2013

President, IPS Assembly

»Only the most educated and qualified experts can open the doors to the development and progress of the society.«

Drago Cotar

Director SZZ since 2013

»Knowledge is future.«

The Slovenian insurance Association is an economic interest grouping of Slovenian insurance and reinsurance companies. The association was established in 1992 and unites 21 Slovenian insurance companies in joint efforts to increase the importance and efficiency of the insurance business: it resolves compensation claims for international car damage, manages the guarantee fund, the compensation body and the information centre, keeps the insurance statistics and publishes statistical data, organises educational seminars for acquiring the licence to become an insurance agent or broker as well as other specific education programmes. The Association is a member of all important international insurance organisations, who aim for progress in the insurance business. The development aims to deepen the expert knowledge of the employees and to raise awareness of the importance of insurance for individuals and society.

Gospodarski pridruženi partnerji MPŠ

V prvem desetletju delovanja MPŠ se je pridružilo še 14 gospodarskih partnerjev MPŠ.

BSH Hišni aparati d.o.o. Nazarje

Tovarna deluje v sklopu multinacionalke Bosch and Siemens Home Appliances Group in zaposluje preko tisoč sodelavcev. Močan razvojni sektor je usmerjen v optimizacijo obstoječih in snovanje novih aparatov za pripravo hrane in napitkov. BSH ima kompetenčni razvojni center za nove rešitve na področjih konstruiranja, preizkušanja, razvoja tehnologije in višanja kakovosti aparatov. Uspešno poslovanje je omogočilo, da danes razvojni in proizvodni program podjetja obsegata poleg aparatov za pripravo hrane tudi celo paleto aparatov za pripravo napitkov.

COSYLAB d. d.

Cosylab zagotavlja sistemsko integracijo in tehnološke rešitve po meri za celotno področje krmilnih sistemov in instrumentalizacije, posebej za pospeševalnike delcev, tokamake in radioteleskope. Večino svojih dosežkov ustvarja v sodelovanju z državnimi ustanovami in gospodarskimi družbami na svetovnem trgu, zlasti z velikimi laboratoriji za pospeševalnike v Evropi, ZDA in Aziji. Podjetje vzdržuje močno povezavo in družabniški odnos z Institutom »Jožef Stefan« od samega začetka, ko so ustanovitelji Cosylaba začeli delovati v skupini pod okriljem IJS. Cosylab v Tehnološkem parku Ljubljana vključuje v delo na svojih projektih tudi študente in sodeluje pri razvoju njihovih ustvarjalnih sposobnosti.

DOMEL d.o.o.

Temeljna usmeritev Domela je trajnostni razvoj. Domel je razvojni dobavitelj dovršenih elektromotornih pogonov, ki temeljijo na lastnih inovativnih tehnologijah. Z vrhunskimi rešitvami je postal vodilni evropski proizvajalec vakuumskih motorjev. Deluje tudi na področjih čistilne tehnike, prezračevalnih sistemov, industrijskih procesov, avtomobilske industrije, medicine in alternativnih energijskih virov. Posebno skrb namenja varovanju okolja z razvijanjem okolju prijaznih tehnologij in proizvodov, posebej zmanjševanju izpustov, recikliranju odpadkov ter učinkoviti uporabi materialnih in energijskih virov.

IPS Industrial Associate Partners

In the first ten years of the IPS, 14 economic partners joined the IPS.

BSH Hišni aparati d.o.o. Nazarje

The plant, with more than 1000 employees, operates within the Bosch and Siemens Home Appliances Group's multinational corporation. A strong development sector is oriented towards the optimisation of existing and the designing of new appliances for preparing food and beverages. BSH has a competence research centre for finding new solutions in the field of construction, testing, technology development and increasing the quality of appliances. Successful operation of the plant allowed for the development and production sector of the company to expand its programme to appliances for the preparation of beverages, in addition to appliances for the preparation of food.

COSYLAB d.d.

Cosylab provides system integration and customer-adapted technological solutions, covering the complete area of control systems and instrumentation, specialized for accelerators, tokamaks and radiotelescopes. The company achieves most of its results in collaboration with national institutions and companies in the world market, especially with large accelerator laboratories in Europe, the USA and Asia. Ever since the company founders started their cooperation under the wings of the JSI, Cosylab has maintained a strong sense of partnership with the Institute. Located at Tehnološki Park, Cosylab also includes students in its research projects and thus participates in developing their creative abilities.

DOMEL d.o.o.

The main focus of Domel is sustainable development. The company develops and supplies high-quality electric-motor drives that are based on the company's own innovative technologies. Offering effective solutions, the company has become a leading European manufacturer of vacuum motors. It also covers the fields of cleaning and air-conditioning systems, industrial processes, the car industry, medicine and alternative energy sources. Special attention is given to environment protection by developing environmentally friendly technologies and products, in particular reducing emissions, recycling waste and efficiently using materials and energy sources.

ETI Elektroelement d.d.

ETI spada med svetovno vodilne proizvajalce rešitev za zaščito stanovanjskih, poslovnih in industrijskih električnih inštalacij, distribucije električne energije, močnostne elektronike in polprevodnikov ter fotovoltaičnih in drugih sistemov s področja obnovljivih virov energije, proizvaja pa tudi izdelke iz tehnične keramike ter orodja in naprave. Razvoj vključuje nove tehnološko napredne rešitve in proizvode na področjih talilnih varovalk, zaščitne stikalne tehnike in vlečene tehnične keramike. Tržno obvladuje jugovzhodno Evropo, na področju talilnih varovalk pa se uvršča med vodilne v svetu. V zadnjih letih se je ETI razvil v mednarodno skupino povezanih družb, ki zaposluje preko 1.700 sodelavcev in posluje s partnerji iz več kot 60 držav.

HYB d.o.o.

Hyb je uveljavljeno visokotehnološko podjetje z več kot štiridesetletno tradicijo v razvoju in proizvodnji visoko zahtevnih specialnih izdelkov za različne aplikacije v medicini, industrijskih napravah in vozilih. Hybovi novi izdelki, kot so brezžični senzorski sistem za prenos krvnega tlaka ter industrijski tlačni senzorji, so plod dolgoletnega vlaganja v raziskave in razvoj. Izdelke odlikujeta inovativnost in vrhunska kakovost, zato se Hyb uvršča med najboljše proizvajalce tovrstnih izdelkov na svetu. V razvoj novih izdelkov si Hyb nenehno prizadeva vključiti nova znanstvena spoznanja.

LTH ULITKI

Podjetje LTH Ulitki, ki zaposluje nad tisoč sodelavcev, ima več kot polstoletno tradicijo in izkušnje na področju razvoja visokotlačnega litja, mehanske obdelave in sestavljanja visokokompleksnih komponent iz aluminijevih zlitin ter v izdelavi orodij za njihovo proizvodnjo. Kupci so predvsem iz evropske avtomobilske industrije. Razvoj je usmerjen v izdelavo najkompleksnejših ulitkov s postopki visokotlačnega litja, v dodatne površinske in mehanske obdelave ter v antikorozivno zaščito. Razvojni programi vključujejo numerične izračune in simulacije izdelovalnih procesov, zagotavljanje kakovosti (CMM, optični nadzor) ter tehnične čistosti, robotiko in avtomatizacijo.

LUKA KOPER d. d.

Dejavnost Luke Koper so pretovorne in skladiščne storitve za vse vrste blaga. Skupina Luka Koper zaposluje okoli tisoč sodelavcev. Razvojna usmeritev je uveljavitev Luke Koper kot vodilnega pristaniškega in logističnega sistema za srednjo in vzhodno Evropo. V tem okviru organizira in izvaja razvojne projekte znotraj pristanišča ter se vključuje tudi v projekte širšega interesa, zlasti v sklopu programov in iniciativ EU. Prednost daje razvoju učinkovitejših tehnoloških postopkov z manjšo porabo materialov in energije ter skrbnim varovanjem okolja, intenziviranju skladiščnih in pretovornih zmogljivosti ter razvoju in gradnji informacijskih in optimizacijskih sistemov za podporo procesom v korist učinkovitosti podjetja, skladnosti z okoljem in uresničevanja trajnostnega razvoja.

ETI Elektroelement d.d.

ETI is one of the world's leading solution providers for the protection of residential, business and industrial electric installations, the distribution of electric energy, power electronics and semiconductors as well as photovoltaic and other systems from the field of renewable energy sources. The company also manufactures products from technical ceramics, tools and devices. The development sector provides new, technologically advanced solutions and products in the field of melting fuses, power protection devices and technical ceramics. Their principal market is South-East Europe, while the melting fuses place them among the leading manufacturers in the world. In the past few years ETI has developed into an international group of companies with more than 1700 employees and partners in over 60 countries.

HYB d.o.o.

Hyb is an acclaimed high-technology company with more than 40 years of tradition in developing and designing complex products for different applications in medicine, industrial devices and the automobile industry. The company's new products, such as wireless sensor systems for the transmission of blood pressure and industrial pressure sensors, are the result of a long-term investment in R&D. The products are characterised by innovation and exceptional quality, which makes the company one of the best manufacturers of such products in the world. Hyb is constantly trying to include new scientific knowledge in the design of its new products.

LTH CASTINGS

LTH Castings is a company with more than 1000 employees and more than 50 years of tradition and experience in the field of development of high-pressure die-casting, mechanical treatment and the composition of complex aluminium components, as well as tools for their production. The company's customers are mainly from the European car industry. The development sector is oriented towards producing the most complex castings using high-pressure die-casting, and towards additional surface and mechanical treatments, and anticorrosive protection. The development programme incorporates numerical calculations and the simulations of production processes, ensuring quality (CMM, optical control) and technical purity, robotics and automation.

LUKA KOPER d.d.

The Luka Koper company provides port and logistics services for all sorts of products and has around 1000 employees. With its development strategy the company strives to become a leading port and logistics system for Central and Eastern Europe. In order to do so it organises and carries out development projects within the port as well as taking part in projects of broader interest, especially in the framework of programmes and initiatives of the EU. It gives priority to the development of more efficient technological processes by reducing the use of materials and energy, and protecting the environment, increasing the storing and loading performance and developing and building information and optimisation systems to improve the processes that will improve the efficiency of the company, environmental friendliness and implement sustainable development.

PREMOGOVNIK VELENJE d.d.

Premogovnik Velenje je tehnološko visoko razvita družba za pridobivanje premoga s skoraj 140-letno tradicijo, ki skupaj s Termoelektrarno Šoštanj zagotavlja Sloveniji letno več kot tretjino električne energije. V Premogovniku in njegovih povezanih družbah je zaposlenih več kot 2.700 delavcev. Premogovnik ima razvojne kapacitete z mednarodno povezavo in priznano ekspertizo na svojih razvojnih področjih, zlasti za inovativne rešitve procesov v proizvodnji premoga, zagotavljanje varnosti postopkov, optimizacijo porabe energije, zniževanje izpustov ogljikovega dioksida in obvladovanje okoljskih vplivov z načrtno dolgoročno usmerjenostjo v trajnostni razvoj. Na teh razvojnih področjih se mednarodno uveljavlja zlasti v okviru projektov EU.

TRIMO d.d.

Skupina Trimo je eno vodilnih evropskih podjetij na področju ovoja zgradb, jeklenih konstrukcij in modularnih prostorskih rešitev. Odlikujejo jih trajnostne, estetsko in tehnično dovršene rešitve, ki jih pod lastno blagovno znamko tržijo v več kot 50 državah. S svojo prodajno mrežo deluje v 27 državah. Proizvodne obrate ima v Sloveniji, Rusiji, Srbiji in Združenih arabskih emiratih. V Trimu osredotočajo razvojne aktivnosti na področja visokoizolativnega tankoslojnega ovoja, zmanjševanja porabe energije v stavbah ter zmanjševanja odtisa ogljikovega dioksida in optimizacije energetske bilance ob hkratnem povečevanju stopnje reciklabilnosti. V Skupini Trimo posvečajo posebno skrb ustvarjalnosti, inovativnosti in poglabljanju znanja svojih več kot 900 zaposlenih.

ŠTORE STEEL d.o.o.

Družba Štore Steel ima poldrugo stoletje tradicije v panogi železarstva in jeklarstva ter bogate izkušnje v proizvodnji jekel za kovanje in strojegradnjo ter za vzmeti, ki so večinoma namenjene za evropsko avtomobilsko industrijo. Zaposluje nekaj več kot 500 sodelavcev. S specializacijo na izbranih področjih in načrtnim prilagajanjem naročilom dosega višjo učinkovitost proizvodnje, boljšo kakovost proizvodov in večjo konkurenčnost na mednarodnem trgu. Razvoj je prednostno usmerjen v tehnologije za proizvodnjo specialnih, visoko kakovostnih jekel, zlasti vzmetnih jekel. Razvojni projekti potekajo tudi na področjih razreza ploščatega jekla, optimiranja sistemov žarjenja, večanja učinkovitosti porabe električne energije in varovanja okolja.

TALUM, Tovarna aluminija d. d. Kidričevo

Talum je uveljavljeni proizvajalec primarnega aluminija, livarskih zlitin, drogov, izparilnikov, rondelic, in ulitkov. Oskrbuje avtomobilsko, pakirno, prehrambeno in gradbeno industrijo. Razvojni projekti so usmerjeni v povečevanje obsega in kakovosti proizvodnih procesov in izdelkov, zlasti s pretaljevanjem odpadnega aluminija, večanje učinkovitosti porabe energije vključno z izrabo odpadne toplote, širjenje proizvodnje in obdelave aluminijevih ulitkov ter skrb za čisto okolje.

PREMOGOVNIK VELENJE d.d.

Premogovnik Velenje is a high-technology coal-mining company with almost 140 years of tradition. Together with Termoelektrarna Šoštanj it provides more than one-third of the electricity in Slovenia. Premogovnik and its associate companies have more than 2700 employees. Its research capacities benefit from international relations and acclaimed expertise in its research fields, especially for innovative approaches to process solutions in coal production, ensuring the safety of the processes, the optimisation of energy consumption, reducing emissions of carbon dioxide and controlling the environmental effects by planning a long-term orientation towards sustainable development. Premogovnik is becoming internationally acclaimed, in particular via EU projects.

TRIMO d.d.

The Trimo Group is one of the leading European companies in the field of building envelopes, steel constructions and modular units. The company boasts sustainable, aesthetic, and technologically advanced solutions which it sells under its trademark in over 50 countries. The sales network is spread over 27 countries, with production plants in Slovenia, Russia, Serbia and the United Arab Emirates. The development sector of the Trimo Group is oriented towards highly insulated thin-layer cladding, reducing the energy consumption in buildings, lowering the carbon-dioxide footprint and optimising the energy balance while increasing the level of recyclability. The Trimo Group devotes special attention to creativity, innovation and broadening the knowledge of its more than 900 employees.

ŠTORE STEEL d.o.o.

Štore Steel is a company with a century and a half of tradition of iron and steel making and considerable experience in the production of steel for applications in forging, machine construction and springs, which are mostly intended for the European car industry. The company has more than 500 employees. Specialising in the selected fields and with a planned adaptation to specific orders, the company achieves better efficiency in production, better quality of the products and competitiveness at the international market. The development sector primarily strives to design technologies for the production of high-quality steel, especially intended for the spring industry. Development projects are also carried out in the fields of shearing flat steel, optimising the annealing systems, increasing the efficiency of energy consumption and environment protection.

TALUM, Tovarna aluminija d. d. Kidričevo

Talum is an acclaimed manufacturer of primary aluminium, cast alloys, billets, evaporators, slugs and castings. Talum's products are used in the automobile, packaging, food and civil engineering industries. Development projects aim to increase the extent and quality of production processes and products, especially by remelting waste aluminium, increasing the efficiency of energy consumption including the use of waste heat, spreading the production and treatment of aluminium castings, as well as protecting the environment.

TERMOELEKTRARNA ŠOŠTANJ d.o.o.

Osrednja dejavnost družbe TEŠ je proizvodnja elektrike in toplote za daljinsko ogrevanje na osnovi lignita in zemeljskega plina. Inštalirana električna moč naprav znaša četrtino inštalirane moči v državi, proizvodnja elektrike pa pokriva tretjino slovenskih potreb. Zaposluje okoli 450 delavcev. Razvoj je usmerjen v uvajanje učinkovitejših in čistejših tehnologij, zniževanje emisij v okolje, ohranjanje kakovosti vode in načrtno uveljavljanje načel trajnostnega razvoja. Bistven doprinos k temu predstavlja izgradnja nadomestnega bloka 6 na osnovi čistih tehnologij, katerega začetek obratovanja je predviden v juniju 2015.

TELEKOM SLOVENIJE d.d.

Telekom Slovenije je celovit ponudnik komunikacijskih storitev v Sloveniji ter uveljavljen operater pri uvajanju in povezovanju novih generacij mobilnih in fiksnih komunikacij, sistemske integracije in računalništva v oblaku ter multimedijskih vsebin. Skupina Telekom Slovenije sodi med celovite ponudnike komunikacijskih storitev v regiji JV Evrope in preko odvisnih družb deluje na trgih te regije, npr. na Kosovu, v Makedoniji, v Bosni in Hercegovini, na Hrvaškem in v Črni gori, kot tudi v Nemčiji in na Gibraltarju. Dejavnost Skupine Telekom Slovenije obsega fiksne in mobilne komunikacije, digitalne vsebine in storitve, multimedijske storitve in digitalno oglaševanje, sistemsko integracijo in računalništvo v oblaku, gradnjo in vzdrževanje telekomunikacijskih omrežij ter ohranjanje naravne in kulturne dediščine na območju Krajinskega parka Sečoveljske soline.

UNIOR Kovaška industrija d.d.

Družba Unior povezuje osemindvajset podjetij, od tega dvaindvajset v drugih državah. V Sloveniji zaposluje nad 2.000 sodelavcev in izvaža nad 90 % proizvodnje. Njene ključne usmeritve pokrivajo področja hladno, toplo in vroče kovanih odkovkov, sintranih proizvodov, ročnega orodja in strojne opreme, posebna dejavnost je turizem. Razvoj je usmerjen zlasti v specifično obdelane odkovke za avtomobilsko industrijo, zahtevne sintrane dele, večanje tržnega deleža v svetovni prodaji ročnega orodja in proizvodnji fleksibilnih obdelovalnih strojev, pa tudi v kakovost turistične ponudbe. Prednost pri razvoju namenjajo novim materialom, avtomatizaciji tehnologij in uveljavljanju principov trajnostnega razvoja.

TERMOELEKTRARNA ŠOŠTANJ d.o.o.

The principal activity of the Šoštanj Thermal Power Plant (TEŠ) is the generation of electricity and district heating energy on the basis of lignite and natural gas. The installed power of the machines covers one-quarter of the installed energy in the country and the produced energy covers one-third of the national demand. The company has 450 employees. The development sector strives for the implementation of more efficient and cleaner technologies, reducing emissions in the environment, preserving the quality of water and implementing the principles of sustainable development. An important contribution to sustainable development is the new Unit 6, built on the basis of clean technologies, which is estimated to start operating in June 2015.

TELEKOM SLOVENIJE d.d.

Telekom Slovenije is a comprehensive provider of communication services in Slovenia and an established operator for introducing and linking the latest generations of mobile and fixed telecommunications, systems integration, cloud computing, and multimedia content. The Telekom Slovenije Group is a comprehensive provider of communication services in the region of South-Eastern Europe – its dependent companies operate in Kosovo, Macedonia, Bosnia and Herzegovina, Croatia, Montenegro, along with Germany and Gibraltar. The Telekom Slovenije Group covers the areas of fixed and mobile communications services, multimedia services and digital advertising, system integration and cloud-computing services, construction and maintenance of telecommunications networks, and the preservation of the natural and cultural heritage in the area of the Sečovlje Saltpans Regional Park.

UNIOR Kovaška industrija d.d.

The UNIOR company is made up of 28 companies, of which 22 are located outside Slovenia. The company has in Slovenia more than two thousand employees and exports more than 90 % of its products. Its global orientation focuses on its four production segments: forging parts, hand tools, machine tools and activities in tourism. The development is oriented especially towards specifically processed forging parts intended for the automobile industry, the production of sintered parts, increasing its market share in world sales of hand tools and machines production, as well as the quality of tourism. The company devotes its development priorities to new materials, the automation of technologies and implementing the principles of sustainable development.

ŠTUDIJSKI PROGRAMI

Prof. dr. Boris Žemva

Prodekan MPŠ

Predsednik –centralne študijske komisije MPŠ

IPS Vice-Dean

President of the IPS Study Commission

Na Mednarodni podiplomski šoli (MPŠ) so študentom na voljo naslednji interdisciplinarni magistrski in doktorski podiplomski študijski programi:

- Nanoznanosti in nanotehnologije, ki zajemajo področja: nanomateriali, nanofizika, nanokemija, bioznanosti, napredni kovinski materiali in nanomehanika;
- Informacijske in komunikacijske tehnologije, ki zajemajo področja: tehnologije znanja, napredne internetne tehnologije, računalniške strukture in sistemi, inteligentni sistemi in robotika ter sodobni koncepti v telekomunikacijah;
- Ekotehnologija, ki zajema področja: postopki in proizvodi z višjo učinkovitostjo uporabe surovin in energije, minimizacija in reciklaža odpadkov, zmanjševanje negativnih učinkov na okolje in izboljševanje ogroženega okolja.

Našteti programi so v nadaljevanju predstavljeni bolj natančno, saj vsak program vključuje temeljne opredelitve področja, umestitev programa v potrebe uporabnikov, cilje in izvajanje študijskega programa. Temu sledijo primeri dosežkov študentov in njihove izkušnje med študijem na MPŠ.

Glavni cilj interdisciplinarnih študijskih programov MPŠ je pripraviti študente za samostojno in skupinsko raziskovalno delo z obvladovanjem sodobnih metod in tehnik znanstvenega raziskovanja ob hkratnem mednarodnem povezovanju. Poglobljeno znanje na izbranih področjih naravoslovnih in informacijskih znanosti, tehnologij in inženirstva bo omogočilo doktorjem in magistrom, ki bodo uspešno zaključili šolanje, pravilno strateško izbiro, razvoj, prenos, optimizacijo, izkoriščanje in nadzor izbranih tehnologij za večjo poslovno učinkovitost ob istočasnem uveljavljanju družbenih interesov za trajnostni razvoj.

Šola omogoča študentom ob bogati ponudbi izbirnih vsebin ciljno usmerjen študij. Za širjenje njihovega splošnega obzorja skrbi z dodatnim izborom temeljnih znanj s področij ekonomije, prava in sociologije. Študij se v veliki večini primerov izvaja individualno, kar pomeni, da ima skoraj vsak študent svojega učitelja, ki mu je vedno na voljo. V nenehnem osebnem stiku z mentorjem se študenti v kratkem času zelo veliko naučijo. Vključeni so v raziskovalne in razvojne projekte, tako industrijske kot tudi mednarodne, predvsem evropske. Na ta način razvijajo sposobnosti tudi na zelo zahtevnem področju sodelovanja z domačo industrijo in mednarodnimi partnerji. Tako ni presenetljivo, da se velika večina doktorjev znanosti in magistrov dogovori za zaposlitev že pred zaključkom študija.

Intenzivni del študija so tudi seminarji, na katerih morajo študenti podati najprej poglobljen pregled in analizo objavljenih tujih dosežkov na svojem področju raziskav, nato pa kakovostno predstaviti in obraniti rezultate svojega raziskovalnega dela. Ti seminarji so v angleškem jeziku, tako da študenti dokažejo sposobnost mednarodnega komuniciranja ter pridobijo tudi potrebno samozavest pri predstavitvi dosežkov svojega raziskovalnega dela ob kritičnem ocenjevanju kolegov, vodje seminarja in koordinatorja seminarjev. Tu velja omeniti še redne letne Študentske konference v sodelovanju z industrijo, ki so namenjene predstavitvi dosežkov in raziskovalno-razvojnih možnosti. Te konference so bile izjemno dobro sprejete tako pri študentih kot tudi pri industrijskih partnerjih MPŠ in predstavljajo edinstven pristop v Sloveniji.

STUDY PROGRAMMES

At the Jožef Stefan International Postgraduate School (IPS) students can choose from the following interdisciplinary postgraduate study programmes:

- *Nanosciences and Nanotechnologies, comprising nanomaterials, nanophysics, nanochemistry, biosciences, advanced metallic materials and nanomechanics;*
- *Information and Communication Technologies, comprising knowledge technologies, advanced internet technologies, computer structures and systems, intelligent systems, robotics, and modern concepts in telecommunications systems;*
- *Ecotechnology, comprising procedures and products with increased efficiency in raw materials and energy consumption, minimizing and recycling of waste, reduction of the negative impact on the environment, and the systematic improvement of the endangered environment.*

The study programmes are later on presented in detail – each programme includes basic research areas, placement within the user's needs, objectives and courses. Deteailed descriptions are followed by examples of student achievements during their studies at the IPS.

The basic objective of the interdisciplinary programmes at the IPS is to qualify the students for independent and joint research assignments by mastering modern research methods and the techniques of scientific research in an international environment. Broadening their knowledge in the areas of natural and information sciences, technologies and engineering provides the master and doctoral students, who successfully finish their studies, the right strategic choice, development, transfer, optimisation, exploitation and control over the selected technologies for wider business efficiency, while implementing social interests for sustainable development.

The School offers students both targeted study and a vast choice of selective content, while their general knowledge is deepened by the additional selection of fundamental knowledge from economics, law and sociology. The courses are mostly conducted individually – every student is assigned a professor who is available for his/her needs. This constant personal contact with a supervisor is very effective for students to learn a great deal in short periods of time. The students are included in R&D projects, be it the industrial and international (mostly European) environments, in order to develop the competence for working in the very demanding area of collaboration with local industry and international partners. The fact that doctoral and master students find employment already during their studies is not surprising.

Seminars are an intensive course form, which requires students to present a thorough overview and analysis of the published achievements of other authors in their field of research, and present and defend their own research results. The seminars are carried out in English to give the students an opportunity for international communication and gain the confidence to present their research achievements in the critical environment of their colleagues, heads of seminars and the coordinator. At this point we should mention the regular annual Students' Conference held in collaboration with industry, where achievements and R&D opportunities are presented. The conferences are well accepted among the students and the IPS industrial partners due to their unique approach in Slovenia.

Katere so torej glavne prednosti študija na MPŠ? Na prvem mestu moramo omeniti izjemno raziskovalno okolje, v glavnem z najmodernejšo raziskovalno opremo na vseh področjih raziskav, nadalje sodelovanje z raziskovalci, ki sodijo na nekaterih področjih v sam svetovni vrh, vselej pa je nivo primerljiv z najboljšimi laboratoriji po svetu. Ne nazadnje je dana možnost vzpostavitve stikov z najbolj uspešnimi predstavniki področij v svetu preko bilateralnega in multilateralnega projektnega sodelovanja. Seveda moramo v tem kontekstu omeniti tudi izjemno prijetno delovno atmosfero z vrsto kolegov in vodilnih raziskovalcev, ki nesebično delijo svoje izkušnje in nasvete in se veselijo skupaj s študenti ob njihovih raziskovalnih uspehih. Poleg tega, da imajo mladi možnost izvajati raziskave na najvišjem možnem nivoju (objave v revijah, kot sta Nature, Science), imajo na MPŠ tudi odprte številne možnosti neposrednega sodelovanja z industrijo. V tem sklopu lahko sodelujejo v reševanju realnih problemov, spoznajo zahteve multidisciplinarnega sodelovanja in načine optimizacije usmerjenega raziskovanja glede na dane realne pogoje. Izkušnje v takem okolju in pogojih prispevajo tudi k razvoju široko ustvarjalne osebnosti, kar je treba še posebej ceniti.

Promocija doktorjev znanosti

Doctoral degree ceremony.

What are the advantages of studying at the IPS? It is important to mention the exceptional research environment, with modern research equipment in every research area, continuing with the collaboration with world-class researchers and a level of work comparable with some of the best laboratories in the world. All in all, the students are given an opportunity to network and gain connections with some of the most successful representatives in their field of work through their bilateral and multilateral collaboration on projects. We should also emphasise the outstanding, friendly working atmosphere, with a number of colleagues and leading researchers who unselfishly share their experience, advice and joy with their students and their research achievements. The IPS students have an opportunity to conduct research at the highest level (publications in the journals like Nature and Science), and to seize the option for direct collaboration with industry. Within this scope of work they can participate in solving real problems, become acquainted with multidisciplinary collaboration and ways of optimising targeted research according to real conditions. The experience from such an environment and conditions contributes to the development of a creative prsonality that should be especially appreciated.

Čestitke prejemniku nagrade Študentske konference

Congratulations to the recipient of the prize at the Students' Conference

Študijski program NANOZNANOSTI IN NANOTEHNOLOGIJE

Prof. dr. Dragan Mihailović

Prodekan MPŠ

Predstojnik študijskega programa Nanoznanosti in nanotehnologije

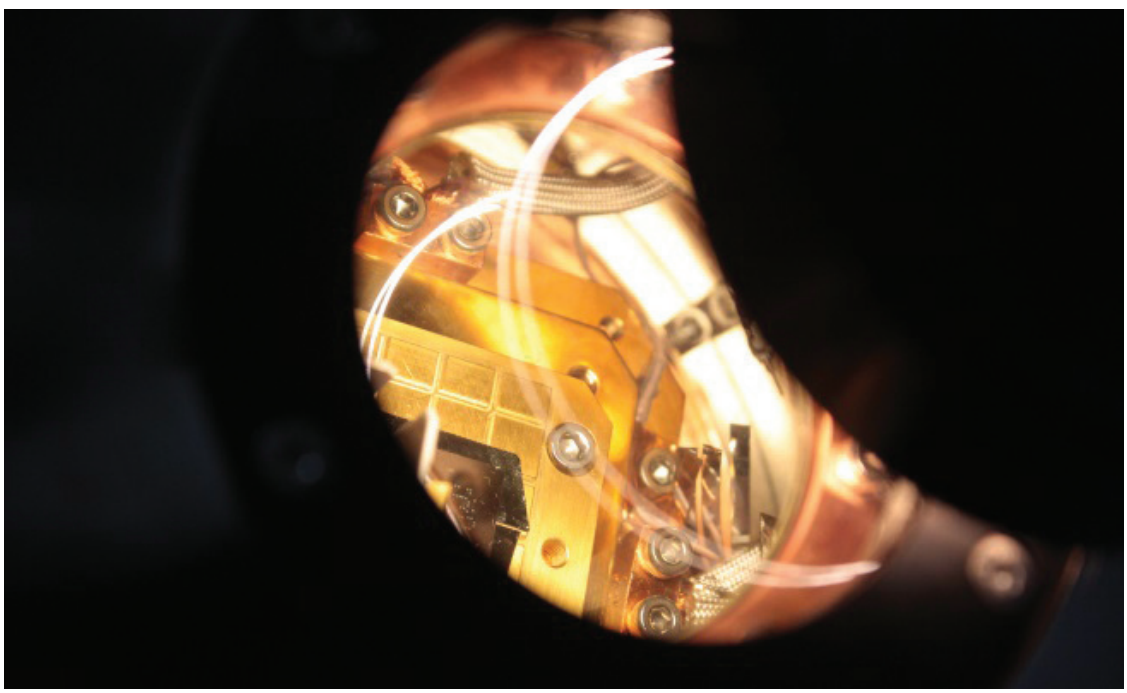
IPS Vice-Dean

Head of the Nanosciences and Nanotechnologies programme

TEMELJNA OPREDELITEV PROGRAMA

Program Nanoznanosti in nanotehnologije predstavlja področje na presečišču fizike, kemije in biologije, vključuje pa tudi elemente elektrotehnike, medicine in okoljskih ved. Raziskuje naravo in uporabo sistemov s komponentami nanometrske velikosti. Ima tudi potencialne aplikacije v skoraj vseh vejah gospodarstva.

Osnovni cilj študija nanoznanosti je doseganje razumevanja strukture in dinamike materialov na atomskem in molekularnem nivoju, na katerem temeljijo njihove makroskopske lastnosti. S poznavanjem metod za mikromanipulacijo atomov in molekul je možno zgraditi nove molekule, naprave in stroje s povsem novimi lastnostmi in novimi možnostmi za uporabo. Kot primer navajamo projekte za zgraditev računalniških komponent atomske velikosti, konstrukcijo novih senzorjev na ravni molekul, ki lahko občutijo posamezne viruse in bakterije, magnete na nivoju posameznih molekul, nanodelce, ki služijo kot nosilci zdravilnih učinkovin za ciljano zdravljenje raka, mikromotorje in molekule, ki lahko uporabljajo sončno svetlobe za kontrolo onesnaževalcev okolja.



Posoda za meritev elektronskih transportnih lastnosti materialov v magnetnem polju

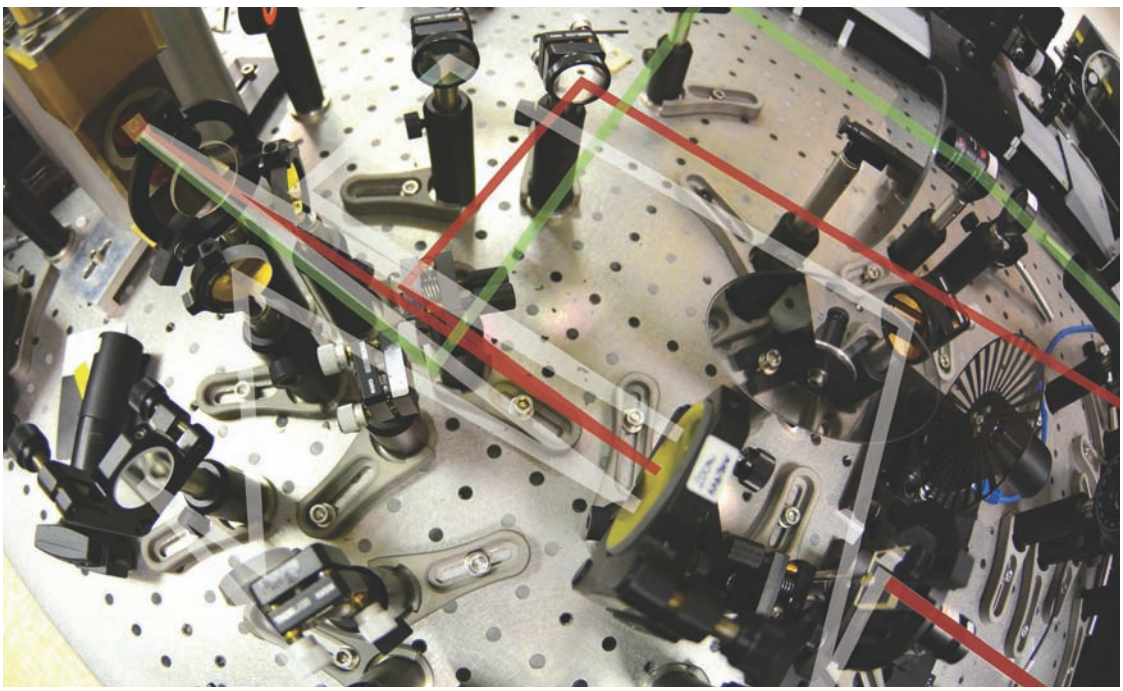
Chamber for the measurement of electron transport properties of materials in a magnetic field

Study Programme
NANOSCIENCES AND NANOTECHNOLOGIES

BASIC DEFINITION OF THE PROGRAMME

The Nanosciences and Nanotechnologies programme represents a field at the intersection of physics, chemistry, and biology, but it also comprises elements of electrotechnics, medicine and environmental sciences. It researches the nature and the use of systems by using components of nanometre size, and it also has potential applications in almost all branches of industry.

The basic objective of the nanoscience study is to understand the structure and dynamics of materials at the atomic and molecular levels on which their macroscopic properties are based. By understanding the methods for the micromanipulation of atoms and molecules, it is possible to create new molecules, devices and machines with unique properties and new possibilities for applications. As an example, we can cite projects for building atomic-size computer components, the construction of new sensors at the molecular level that can sense particular viruses and bacteria, magnets at the level of individual molecules, nanoparticles that serve as the carriers of remedial agents for targeted cancer treatments, micromotors, and molecules that can use sunlight to control environmental pollutants.



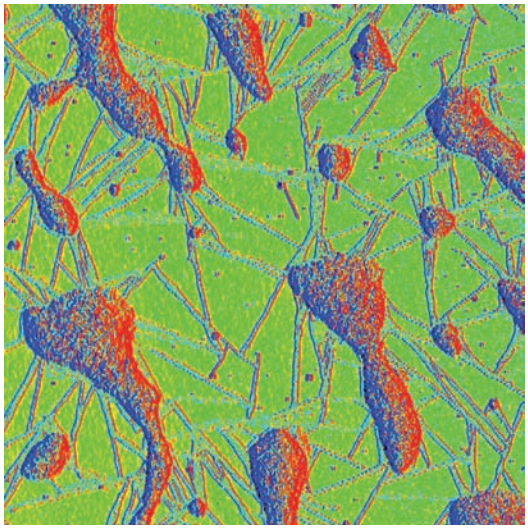
Eksperiment za raziskavo dinamike osnovnih optičnih, elektronskih in magnetnih vzbuditev v snovi

Experimental setup for the study of the dynamics of elementary optical, electronic and magnetic excitations in materials

UMEŠČENOST PROGRAMA V POTREBE UPORABNIKOV

Program nanoznanosti in nanotehnologije je interdisciplinarni podiplomski študijski program, ki zajema naslednja raziskovalna področja: 1. novi nanomateriali in nanokemija, 2. nanofizika (ki vključuje fiziko umetnih nanostruktur ter razvoj metod za raziskavo in nanomanipulacijo atomov in molekul in njihove dinamike), 3. bioznanosti (vključno z biomedicino), 4. napredni kovinski materiali, 5. nanomehanika (ki vključuje mehaniko časovno odvisnih materialov).

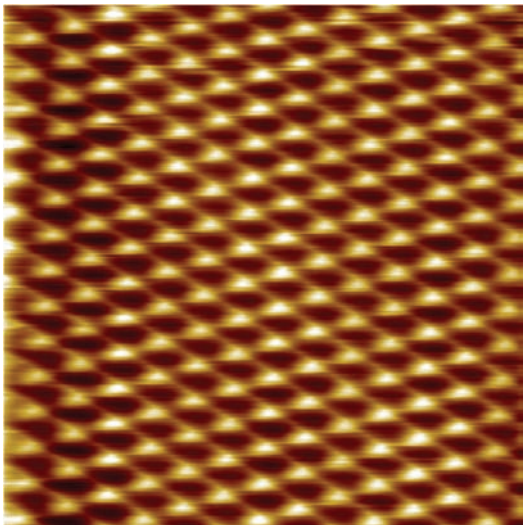
Vse usmeritve vključujejo tudi posredovanje temeljnih znanj za uspešno komunikacijo s strokovnjaki na področjih gospodarskega in civilnega prava, mikroekonomike podjetij in projektnega managementa ter osnov trajnostnega razvoja.



Z MoSI nanožicami povezane beljakovine GFP

MoSI nanowires connected with GFP molecules

GFP = green fluorescent protein
zelena fluorescentna beljakovina



LT Nanoprobe STM na Ag (111) pri 4,5 K (Omicron Nanotechnology GmbH)

LT Nanoprobe STM on Ag (111) at 4.5K (Omicron Nanotechnology GmbH)

STM = scanning tunneling microscopy
vrstična tunelska mikroskopija

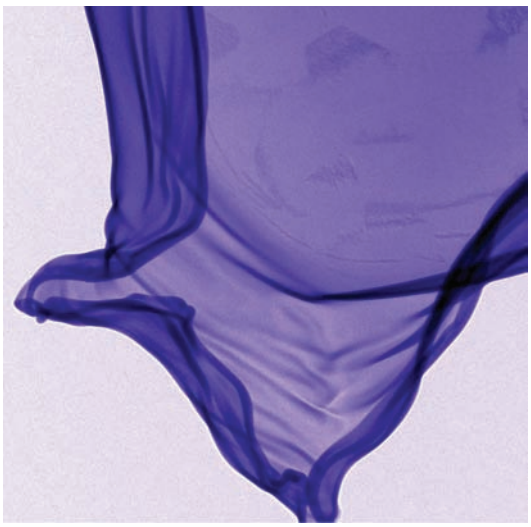
CILJI ŠTUDIJSKEGA PROGRAMA

Poseben poudarek študijskega programa in njegovi končni cilji temeljijo na raziskavah nanokompozitov in hibridnih materialov, »pametnih« keramičnih, kovinskih in drugih materialov ter tankih plasti, submikronskih vlaken, nanokemije, kjer se izvaja sinteza novih molekul z manipulacijo posameznih atomov, biomaterialov, posebej novih vrst učinkovin in direktnega prenosa učinkovin na ciljna mesta, molekularnih motorjev, »pametnih« feroelektrikov in piezoelektrikov, organskih in anorganskih nanocevk, nanožic in kvantnih pik, »pametnih« gelov, materialov, potencialno uporabnih za miniaturizacijo elektronskih komponent in elementov za kvantne računalnike, materialov, uporabnih za »spintroniko«, kjer namesto elektronov logične in druge operacije izvajamo s spini in kjer pričakujemo novo stopnjo miniaturizacije, ter novih raziskovalnih tehnik in metod za študij strukture in dinamike nanomaterialov. Odpira se tudi možnost novih področij kemije in farmacije, kjer sintetiziramo nove spojine na molekularnem nivoju.

PROGRAMME IN RELATION TO THE USER'S NEEDS

The Nanosciences and Nanotechnologies programme is a cross-disciplinary postgraduate study programme comprising the following research areas: 1. new nanomaterials and nanochemistry, 2. nanophysics (which includes the physics of artificial nanostructures as well as the development of methods for the research and nanomanipulation of atoms and molecules and their dynamics), 3. biosciences (including biomedicine), 4. advanced metallic materials, 5. nanomechanics (including the mechanics of time-dependent materials).

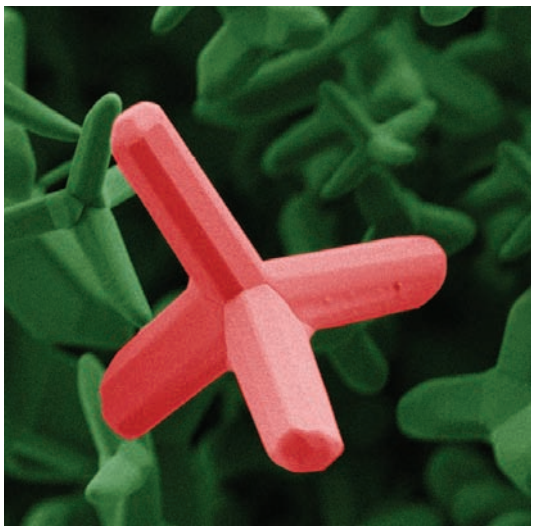
All the courses also include the provision of basic skills for a successful communication with experts in the areas of economics and civil law, corporate micro-economics and project management, and the basics of sustainable development.



TEM posnetek ionsko jedkanega Ti-Zr-Ni vzorca

TEM image of ion-etched Ti-Zr-Ni sample

TEM = transmission electron microscopy
presevna elektronska mikroskopija



Posnetek ZnO nanokristalov s SEM

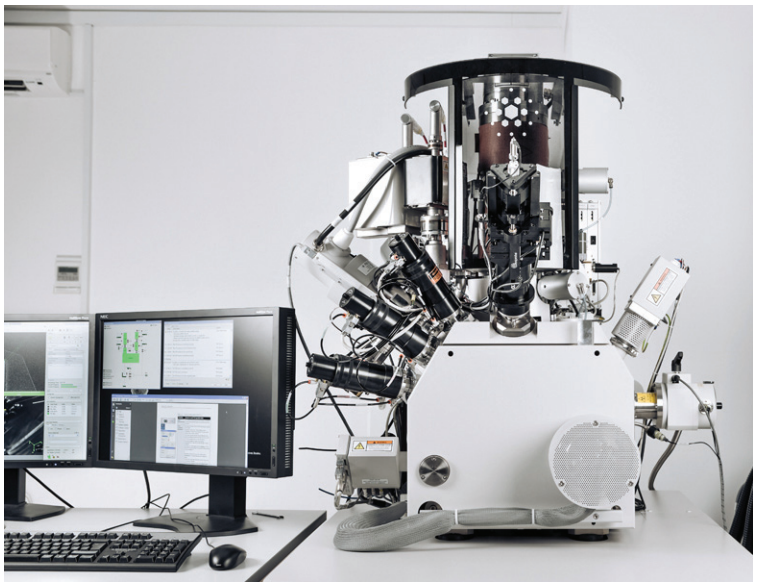
SEM image of ZnO nanocrystals

SEM = scanning electron microscopy
vrstična elektronska mikroskopija

OBJECTIVES OF THE STUDY PROGRAMME

Special emphases of the study programme and its ultimate objectives are placed on research into nanocomposites and hybrid materials, »smart« ceramics, metallic and other materials and thin films, submicron fibres, nanochemistry involving the synthesis of new molecules through the manipulation of individual atoms, biomaterials, particularly new types of agents and the direct delivery of agents to the target sites, molecular motors, »smart« ferroelectrics and piezoelectrics, organic and inorganic nanotubes, nanowires and quantum dots, »smart« gels, materials potentially usable for miniaturizing electronic components and elements for quantum computers, materials usable for »spintronics« where the spins are used instead of the electrons to perform logic and other operations, and where a new degree of miniaturization is expected, new research techniques and methods to study the structure and dynamics of nanomaterials. There is also the possibility to develop new areas in chemistry and pharmacy where new compounds are synthesized at the molecular level.

Interdisciplinarni program na področju nanoznanosti in nanotehnologije povezuje vrsto naravoslovnih in tehniških disciplin. Poseben poudarek daje projektnemu raziskovalnemu delu študentov, mentorjev in profesorjev kot integralnemu delu študijskega programa. Ciljna znanja, ki jih študentje pridobijo tudi iz civilnega in gospodarskega prava, ekonomike, patentnega prava in intelektualne lastnine ter načinov zbiranja »venture« kapitala, naj bi študentom po končanem študiju omogočila boljšo komunikacijo z eksperti na teh področjih za razvoj in komercializacijo rezultatov nanotehnoloških raziskav.



Fokusirani ionski mikroskop

Focussed ion beam microscope (FIB)

IZVAJANJE ŠTUDIJSKEGA PROGRAMA

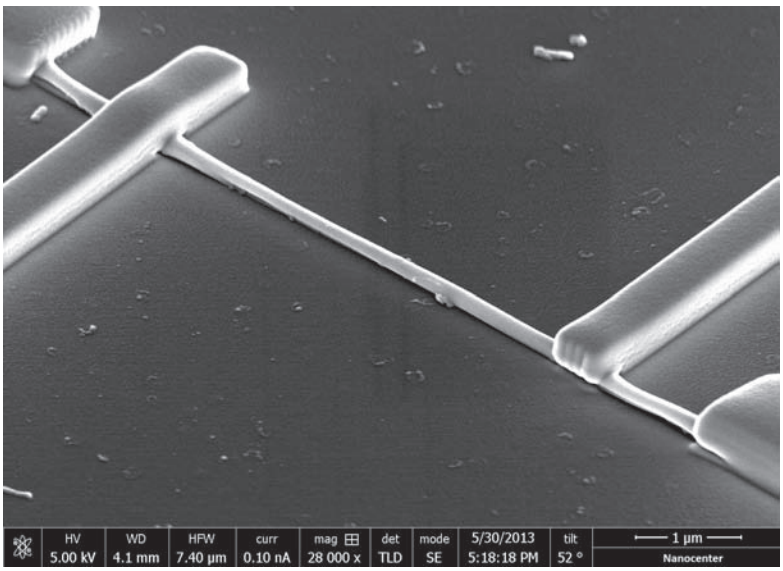
Študijski program Nanoznanosti in nanotehnologije temelji na usposabljanju kandidatov za samostojno in skupinsko raziskovalno in razvojno delo, delo na aplikativnih projektih v industriji in s tem sposobnost uporabe znanja v praksi, obvladovanje metod in tehnik znanstvenega raziskovanja, vključevanje v mednarodne povezave raziskovalnega in razvojnega dela, reševanje problemov pri prenosu in adaptaciji novih tehnologij v proizvodnjo ter izvajanje vodstvenih funkcij na področju poslovanja, upravljanja, vodenja raziskav in raziskovalnega managementa.

Raziskovalno delo se opravlja v sodelovanju z Nanocentrom (www.nanocenter.ijs.si), Centrom odličnosti NAMASTE (www.conamaste.si) in Centrom za integrirane pristope v kemiji in biologiji proteinov (www.cipkebip.org), ki zagotavljajo vrhunsko opremo, ter partnerskimi organizacijami Institutom »Jožef Stefan«, Kemijskim inštitutom, Nacionalnim inštitutom za biologijo, Inštitutom za kovinske materiale in tehnologije ter drugimi ustanovami, ki so nosilke raziskovalnih projektov in programov.

Specifične kompetence glede na usmeritev posameznikovega študijskega programa so:

- poznavanje osnovnih laboratorijskih in spektroskopskih tehnik s področja nanoznanosti in nanotehnologije,
- razumevanje sistemov na atomski in molekularni skali,

The cross-disciplinary programme in the area of nanosciences and nanotechnologies integrates a number of natural science and technical disciplines. Special emphasis is placed on the project-based research work of the students, supervisors and professors as an integral part of the study programme. Target knowledge and skills that the students also obtain in the areas of civil and commercial law, economics, patent and intellectual property law, and the methods of raising venture capital, should enable students, upon completion of their studies, to better communicate with experts in these areas in order to develop and commercialize the results of their nanotechnology research.



MoN nanožica s štirimi merilnimi Pt kontakti. Kontakti so pripravljeni s FIB mikroskopom in omogočajo meritve električne upornosti.

A molybdenum nitride nanowire with four Pt contacts made using a FIB microscope for electrical resistance measurements.

IMPLEMENTATION OF THE STUDY PROGRAMME

The Nanosciences and Nanotechnologies programme is based on training candidates for individual and team R&D work, work on projects applicable in industry and thus the ability to use knowledge in practice, mastering the methods and techniques of scientific research, inclusion in international R&D work, solving problems that arise when new technologies are transferred and adapted in industry, and performing lead functions in the areas of management, research conduct and research management.

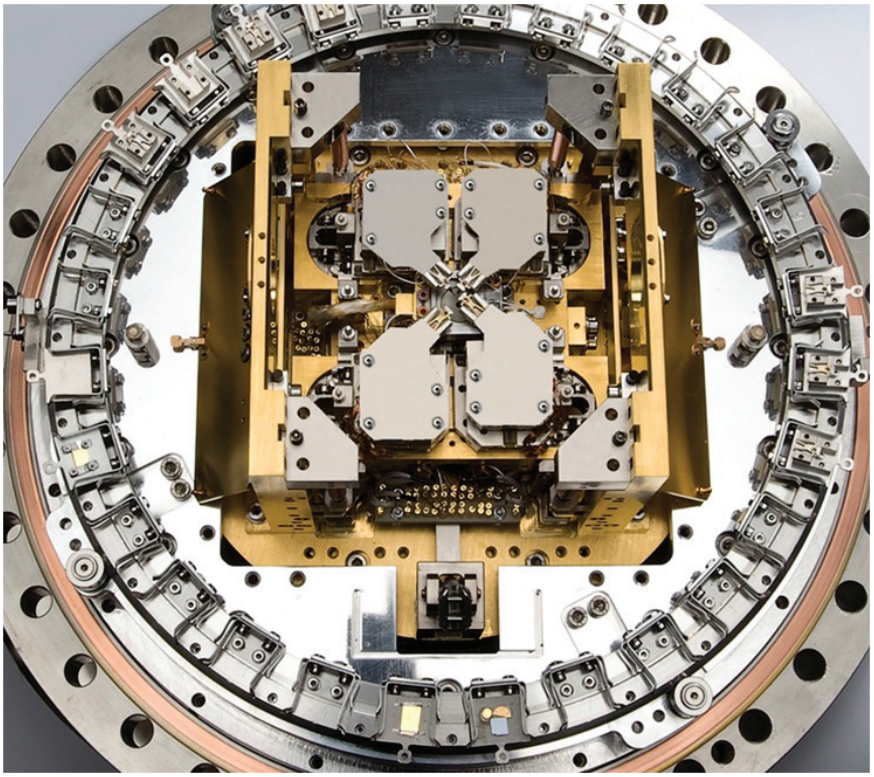
Research work is carried out in collaboration with the Nanocentre (www.nanocenter.ijs.si), the Centre of Excellence NAMASTE (www.conamaste.si) and the Centre of Excellence for Integrated Approaches in Chemistry and Biology of Proteins (www.cipkebip.org), which provide top-of-the-range equipment, and with partner organizations: the Jožef Stefan Institute, the Institute of Chemistry, the National Institute of Biology, the Institute of Metals and Technology, and other institutions that are the holders of research projects and programmes.

Subject-specific competences are:

- *knowing the basic laboratory and spectroscopic techniques in the field of nanosciences and nanotechnologies,*
- *understanding the systems on the atomic and molecular scales,*

- sposobnost povezovanja različnih znanj pri prepoznavanju in analizi nanotehnoloških problemov,
- sposobnost za analizo etičnih aspektov praks, institucij in vrednotenj, povezanih z nanotehnologijo,
- poznavanje konceptov nanotehnologije,
- pridobitev osnov naravoslovnega in tehniškega znanja s področja nanotehnologije z združevanjem obstoječih rešitev.

Med svojim študijem doktorandi poglabljajo znanja metod in tehnik, ki jih pri svojem raziskovalnem delu direktno uporabljajo, in se seznanjajo s temami, ki so ključne za razumevanje vpetosti njihovih raziskav v sodelave z drugimi raziskovalnimi skupinami. Predloga za preverjanje znanja so pri mnogih predavateljih seminarji, pri katerih morajo študenti pripraviti raziskovalni projekt iz tematike predmeta. Pri nekaterih predmetih, kot je na primer »Od kristalov do 3D strukture makromolekul«, pa morajo študenti določiti eno ali več 3-dimenzionalnih struktur proteina, ki so ga izrazili in kristalizirali. Pri praktičnih predmetih, kot je mikroskopija, pa učni proces poteka predvsem na aparaturah.



Merilna postaja Omicron LT nanoprobe sistema s štirimi konicami za tunelsko mikroskopijo

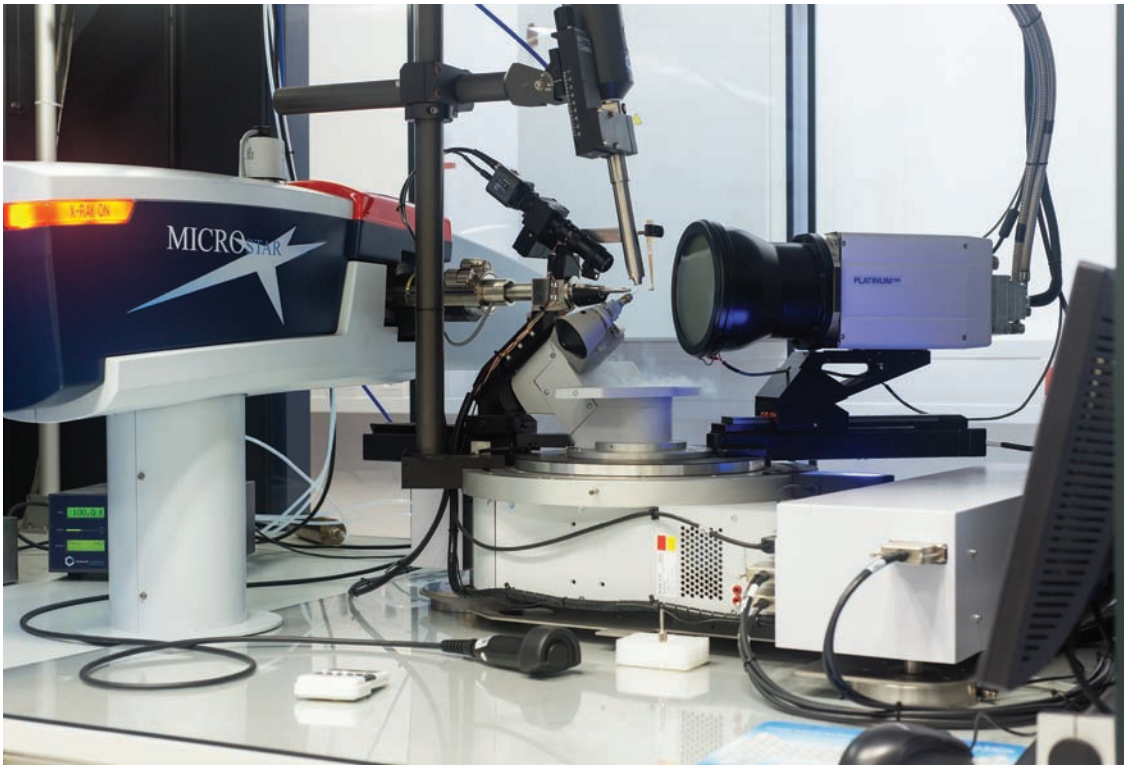
Measurement stage of an Omicron LT Nanoprobe system with four tunneling microscope tips

Splošno preverjanje napredka pri raziskavah in strokovnem znanju najbolj pogosto poteka v obliki seminarjev, kjer študenti predstavijo vizijo, izvajanje in zaključke lastnega projekta. Velik del učenja poteka preko interakcije med kolegi, prenosa znanja iz generacije v generacijo ter profesorji, s katerimi so nenehno v stiku tekom raziskovalnega dela.

- *an ability to combine various skills and knowledge in order to identify and analyse nanotechnology issues,*
- *an ability to analyse ethical aspects of practices, institutions and valuations associated with nanotechnology,*
- *knowing the concepts of nanotechnology,*
- *obtaining the basic natural-science and technical knowledge in the field of nanotechnology by combining the existing solutions.*

During their studies, doctoral students deepen their knowledge of methods and techniques that are directly used in their research work and they also become acquainted with the topics that are crucial for understanding how their research is related to other collaborating research groups. Numerous lecturers assess the students' knowledge on the basis of seminars, where students have to prepare a subject-specific research project. For some subjects, i.e., »From Crystals to 3D Structure of Macromolecules«, students have to determine one or more 3-dimensional structures of a protein they defined and crystallized. For practical subjects, such as microscopy, the learning process takes place on the equipment.

The general evaluation of the progress in research and professional knowledge is most often made in the form of seminars, where students present their vision, execution, and the conclusions of their project. In a large part the learning is carried out through the interaction with colleagues, the transfer of knowledge from generation to generation, and professors who are in constant contact with students doing their research work.

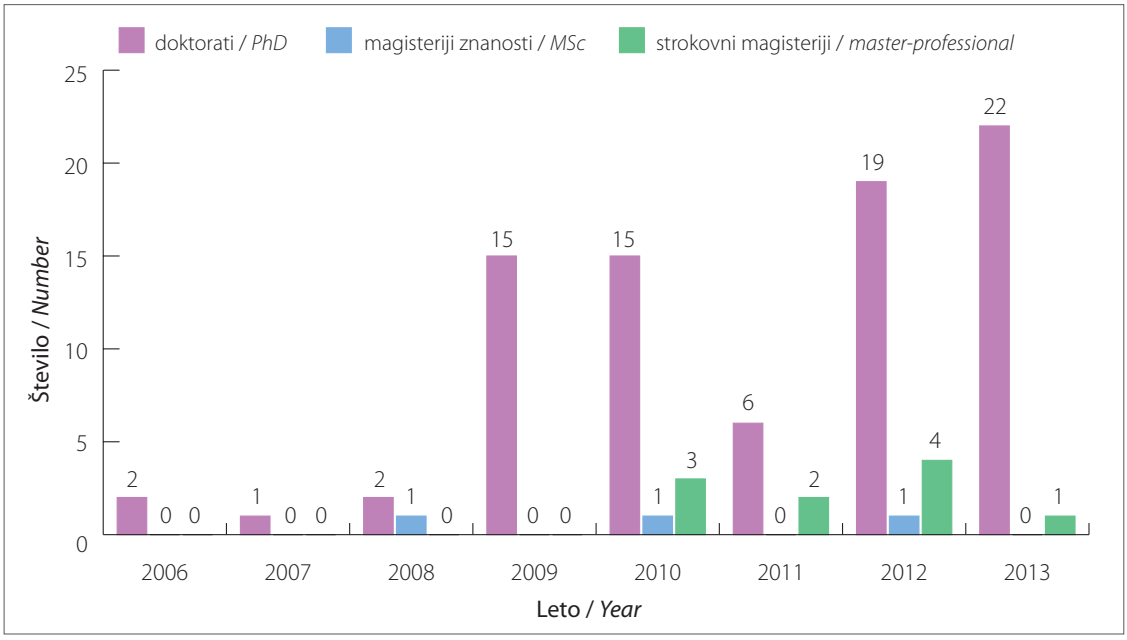


Sistem za določevanje struktur kristalov makromolekul

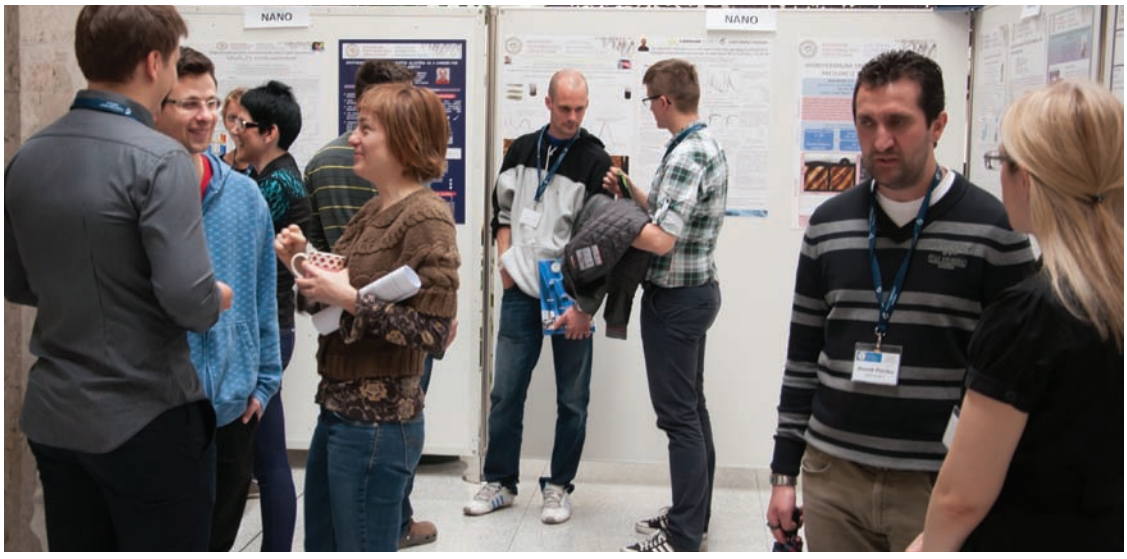
The system for macromolecular crystal structure determination

DOKTORJI IN MAGISTRI NANOZNANOSTI IN NANOTEHNOLOGIJE

V prvih 10 letih letih delovanja MPŠ je na programu Nanoznanosti in nanotehnologije doktoriralo 82 in magistriralo 13 kandidatov. Od tega je študij končalo 20 kandidatov iz tujine.



Doktorati in magisteriji na MPŠ v prvi dekadi, skupaj 95.
PhD and MSc at IPS in the first decade, total 95.



Priprave predstavitve posterjev
Poster session preparation

DOCTORS AND MASTERS OF NANOSCIENCES AND NANOTECHNOLOGIES

In the first 10 years of the existence of the Jožef Stefan International Postgraduate School , 82 candidates have been awarded their doctoral degree in the Nanosciences and Nanotechnologies programme and 13 candidates, their master's degree. 20 of those who completed their studies were from other countries.

Panelna razprava

Panel discussion

PRIMERI DOSEŽKOV

- **Študij kompleksnih snovi s femtosekundno spektroskopijo**

Študij osnovnih vzbuditev v kompleksni snovi s pomočjo femtosekundne spektroskopije postaja vedno bolj uveljavljena metoda za karakterizacijo zanimivih nanomaterialov. Doktorsko delo **dr. Ljupke Stojčevske** z naslovom **Femtosekundna relaksacijska dinamika v snoveh s kolektivnimi elektronskimi stanji: kupratni in železo-pniktidni superprevodniki ter sistemi z valom gostote naboja** pod mentorstvom doc. dr. Tomaža Mertlja in somentorstvom prof. dr. Dragana Mihailovića obravnava različne sisteme, kot so pniktidni in kupratni superprevodniki ter sistemi z valovi gostote naboja. Poleg omenjenega je z adaptacijo metode možno doseči tudi povsem nova skrita stanja v snovi. Odkritje skritega stanja, na katerem je delala dr. Ljupka Stojčevska, je bilo objavljeno v reviji *Science*. Objave: 9 člankov v revijah z SCI. Primer: Stojchevska Ljupka, Vaskivskyi Igor, Mertelj Tomaž, Kušar Primož, Svetin Damjan, Brazovskii Serguei, Mihailović Dragan. Ultrafast switching to a stable hidden quantum state in an electronic crystal. *Science*, 2014, 344, 6180, 177-180.

Trajektorija sistema iz normalnega stanja v skrito stanje po vzbuditvi z laserskim sunkom

The trajectory of a system from a normal to a hidden state after excitation with a laser pulse

- **Izboljšanje mehanskih in termičnih lastnosti visokogliničnega porcelana**

Dr. Martina Oberžan iz podjetja ETI Elektroelement, Izlake, se je v okviru svojega doktorskega dela **Visoko glinični porcelan z izboljšanimi mehanskimi in termičnimi lastnostmi** (mentorica prof. dr. Marija Kosec) posvetila raziskavam kompleksnih procesov, ki potekajo med žganjem v visoko glinčnem porcelanu. Določila je optimalno sestavo visoko glinčnega porcelana za doseganje večje odpornosti na termične šoke in dosežke vpeljala v proizvodnjo po tehnoloških postopkih, ki jih obvladujejo v podjetju ETI. Nova sestava elektrotehničnega porcelana z izboljšanimi lastnostmi je tako plod lastnega znanja, z njim ETI širi nabor keramičnih materialov za elektrotehniko ter povečuje kakovost in zanesljivost delovanja elektrotehničnih izdelkov, kar predstavlja za podjetje konkurenčno prednost. Objave: 1 članek, 2 patenta.

Raziskovalna skupina je leta 2009 prejela Puhovo priznanje za izume, razvojne dosežke in uporabo znanstvenih izsledkov pri razvoju visoko glinčnega porcelana z izboljšanimi mehanskimi in toplotnimi lastnostmi (dr. Martina Oberžan, dr. Janez Holc, mag. Marjan Buh, Ivan Lavrač in prof. dr. Marija Kosec).

EXAMPLES OF ACHIEVEMENTS

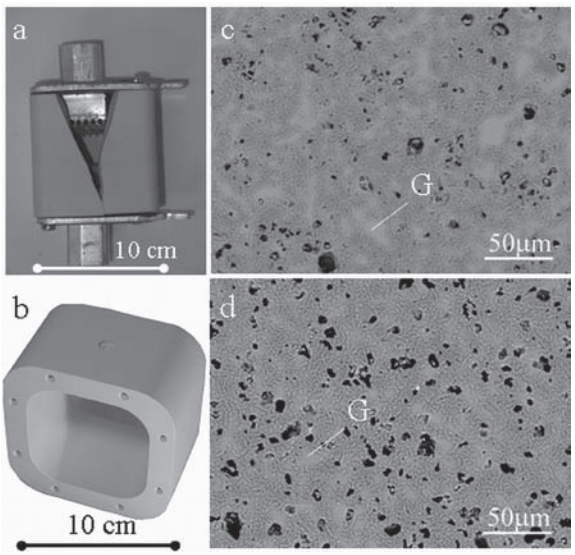
- ***Study of complex materials with femtosecond spectroscopy***

The study of the basic excitation in a complex substance by means of femtosecond spectroscopy is becoming an ever more valid method for the characterization of interesting nanomaterials. The doctoral dissertation ***Femtosecond relaxation dynamics in collective-electronic-state materials: cuprate and iron-pnictide superconductors and charge-density wave systems*** *by* ***Dr. Ljupka Stojčevska*** *(Supervisor Assistant Professor Tomaž Mertelj, Co-Supervisor Professor Dragan Mihailović) deals with various systems such as pnictide and cuprate superconductors and systems with charge-density waves. In addition, by adapting the method it is also possible to achieve completely novel hidden states in a substance. The discovery of the hidden state, made by Ljupka Stojčevska, was published in the journal Science. Publications: 9 articles in SCI journals. Example: Stojchevska Ljupka, Vaskivskyi Igor, Mertelj Tomaž, Kušar Primož, Svetin Damjan, Brazovskii Serguei, Mihailović Dragan. Ultrafast switching to a stable hidden quantum state in an electronic crystal. Science, 2014, 344, 6180, 177-180.*

- ***Improving mechanical and thermal properties of high-alumina porcelain***

In her doctoral dissertation ***High-alumina porcelain with improved mechanical and thermal properties*** ***Dr. Martina Oberžan*** *(Supervisor Professor Marija Kosec), researched the complex processes taking place during firing in high-alumina porcelain. She determined the optimal composition of high-alumina porcelain to achieve a higher resistance to thermal shocks, and introduced it into production according to the technological procedures used in the ETI company. A new composition of electrotechnical porcelain with improved properties is thus the product of their own know-how; in this way ETI extends the list of ceramic materials for electrotechnics and improves the high quality and reliability of functioning for electrotechnical products, which for the company presents a competitive advantage. Publications: 1 article, 2 patents.*

In 2009 the research team was awarded the Puh award for inventions, developmental achievements and the application of scientific results in developing high-alumina porcelain with improved mechanical and thermal properties (Dr. Martina Oberžan, Dr. Janez Holc, MSc Marjan Buh, Ivan Lavrač and Professor Marija Kosec).

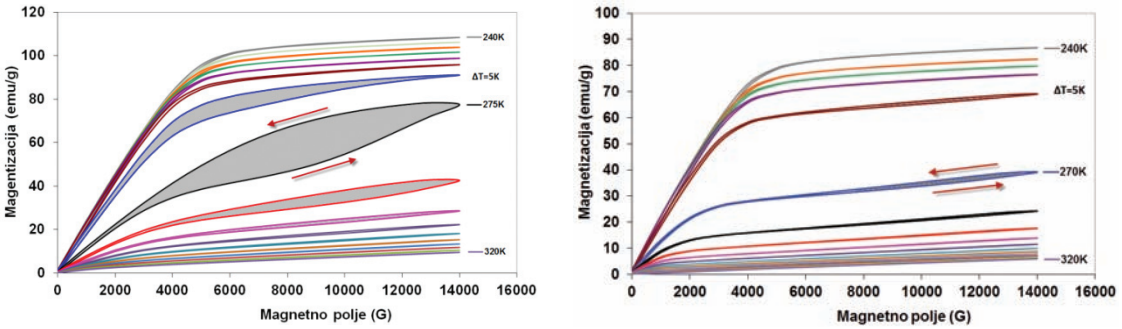


a) Razpokano ohišje varovalke, izdelano iz standardnega gliničnega porcelana, po električni obremenitvi, b) ohišje varovalke, izdelano iz gliničnega porcelana z modificirano sestavo, po testiranju ni razpokalo, kar potrjuje boljšo odpornost materiala na termične šoke; c) mikrostruktura standardnega gliničnega porcelana; in d) mikrostruktura gliničnega porcelana z modificirano sestavo z enakomerno porazdeljeno steklasto fazo (G).

a) Cracked housing of an electric fuse from the standard high-alumina porcelain after electrical testing, b) housing of an electric fuse from the high-alumina porcelain with the modified composition which survived electrical testing without cracking, confirming a better resistance of the material to thermal shocks; c) microstructure of the standard high-alumina porcelain, and d) microstructure of the high-alumina porcelain with the modified composition with the uniformly distributed glassy phase (G).

- **Magnetokalorični materiali za uporabo v magnetnih hladilnikih**

V sistematični študiji vpliva sestave, faznih razmerij ter mikrostrukture na nano nivoju je **dr. Benjamin Podmiljšak** v svoji doktorski disertaciji (mentorica prof. dr. Spomenka Kobe in somentor doc. dr. Paul J. McGuiness) **Raziskave mikrostruktur magnetokaloričnih materialov na osnovi redkih zemelj in elementov prehoda za uporabo pri sobni temperaturi** dokazal, da ima mikrostruktura zelo velik vpliv na končne lastnosti magnetokaloričnih materialov na osnovi $Gd_5(Si,Ge)_4$. Navadno se zgodi strukturni prehod iz ortorombske v monoklinsko fazo pod vplivom zunanjega magnetnega polja pri poljih, manjših od 1 T. Če pa mikrostrukturo modificiramo z dodatkom majhne količine železa in hitrim ohlajanjem med samim obločnim taljenjem, se strukturni prehod pojavi šele pri višjih magnetnih poljih. Material, ki ga je izdelal, ima odlične lastnosti z minimalnimi histereznimi izgubami in je primeren za uporabo v magnetnem hlajenju. Objave: 10 člankov, 1 patent. Primer: Podmiljšak Benjamin, McGuiness Paul J., Miklavič Blaž, Žužek Rožman Kristina, Kobe Spomenka. Magnetocaloric properties and nanoscale structure of Fe-doped $Gd_5Ge_2Si_2$ alloys. *Journal of Applied Physics*. 2009, 105, 7, 07A941-1-07A941-3.



Magnetizacija zlitine $Gd_5(Si,Ge)_4$ v odvisnosti od temperature pri vzorcih brez dodatka železa (levo) in z dodatkom železa (desno)

Magnetization of Gd5(Si,Ge)4 as a function of temperature in samples without (left) and with (right) the addition of a small amount of iron

- **Dielektrične lastnosti keramike in plasti $KTaO_3$ ter plasti $KTa_{0,6}Nb_{0,4}O_3$, merjene v širokem frekvenčnem območju**

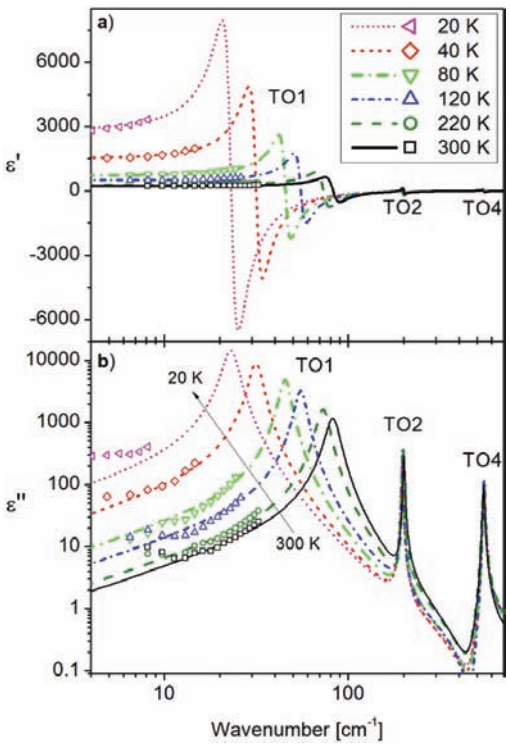
Dr. Sebastjan Glinšek je v doktorskem delu Dielektrične lastnosti keramike in plasti $KTaO_3$ ter plasti $KTa_{0,6}Nb_{0,4}O_3$, merjene v širokem frekvenčnem območju (mentorica prof. dr. Marija Kosec, somentor prof. dr. Zdravko Kutnjak) s pomočjo mehanokemijske aktivacije reagentov pripravil enofazno gosto keramiko kalijevega tantalata. Dielektričnost keramike pri 5 K in 1 kHz z več kot 95 % relativno gostoto je bila primerljiva z vrednostjo, ki jo dosegajo monokristali, in je med največjimi objavljenimi vrednostmi za kalijev tantalat brez dodatkov za sintranje ali dopantov. Rezultat nakazuje, da je prispevek mej zrn k dielektričnim lastnostim tantalata zanemarljiv, kar je izrazito drugače, kot velja za najbolj raziskani feroelektrik, stroncijev titanat. Objave: 7 člankov. Primer: Glinšek Sebastjan, Nuzhnyy Dmitri, Petzelt Jan, Malič Barbara, Kamba Stanislav, Bovtun Viktor, Kempa Martin, Skoromets Volodymyr, Kužel Petr, Gregora Ivan. Lattice dynamics and broad-band dielectric properties of the $KTaO_3$ ceramics. *Journal of Applied Physics*, 2012, 111, 10, 104101-1-104101-6.

- ***Magnetocaloric materials for applications in magnetic refrigeration***

In a systematic study of the influence of composition, phase relations and microstructure on the nano level, ***Dr. Benjamin Podmiljšak*** *in his dissertation* ***Microstructural investigations of rare-earth transition-metal-based magnetocaloric materials for near-room-temperature applications*** *(Supervisor Professor Spomenka Kobe and Co-Supervisor Assistant Professor Paul J. McGuiness) proved that microstructure has a critical influence on the final properties of magnetocaloric materials based on $Gd_5(Si,Ge)_4$. The structural transformation from the orthorhombic to the monoclinic phase under the influence of the applied magnetic field originates at fields lower than 1 T. By modifying the microstructure with the addition of small amounts of iron and a fast cooling regime the structural change moves to higher fields. The final material produced had excellent properties with minimal hysteresis losses. Publications: 10 papers, 1 patent. Example: Podmiljšak Benjamin, McGuiness Paul J., Miklavič Blaž, Žužek Rožman Kristina, Kobe Spomenka. Magnetocaloric properties and nanoscale structure of Fe-doped $Gd_5Ge_2Si_2$ alloys. Journal of Applied Physics. 2009, 105, 7, 07A941-1-07A941-3.*

- ***Processing-Dependent Broadband Dielectric Properties of $KTaO_3$ Ceramics, Films and $KTa_{0.6}Nb_{0.4}O_3$ Films***

In his doctoral dissertation Processing-Dependent Broadband Dielectric Properties of $KTaO_3$ Ceramics, Films and $KTa_{0.6}Nb_{0.4}O_3$ Films (Supervisor Professor Marija Kosec, Co-Supervisor Professor Zdravko Kutnjak), ***Dr. Sebastjan Glinšek*** *prepared single-phase, dense $KTaO_3$ ceramics by means of the mechanochemical activation of reagents. The dielectric permittivity of ceramics at 5 K and 1 kHz with more than 95 % relative density was comparable to the value achieved with monocrystals and ranks among the highest values for $KTaO_3$ without additives for sintering or dopants. The result indicates that the contribution of grain boundaries to the dielectric properties of the tantalate is insignificant, which is markedly different from most researched ferroelectric strontium tantalate. Publications: 7 articles. Example: Glinšek Sebastjan, Nuzhnyy Dmitri, Petzelt Jan, Malič Barbara, Kamba Stanislav, Bovtun Viktor, Kempa Martin, Skoromets Volodymyr, Kužel Petr, Gregora Ivan. Lattice dynamics and broad-band dielectric properties of the $KTaO_3$ ceramics. Journal of Applied Physics, 2012, 111, 10, 104101-1-104101-*

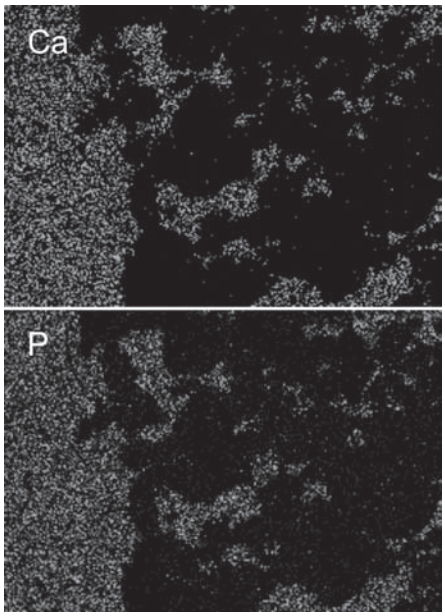


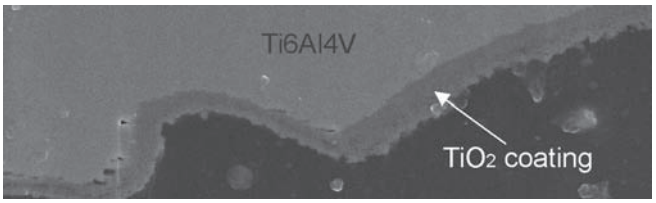
a) Realni ε'(ω) in b) imaginarni del ε"(ω) kompleksne dielektričnosti ε*(ω) keramike $KTaO_3$, izračunan iz prilagajanja modela meritvam v IR in THz območju pri različnih temperaturah (simboli: podatki za THz območje).

a) Real ε'(ω) and b) imaginary ε"(ω) parts of the complex dielectric function ε(ω) of $KTaO_3$ ceramics calculated from the simultaneous fits of IR and THz data (the latter shown as symbols) measured at different temperatures.*

- **Razvoj prevlek na zlitini Ti6Al4V za novo generacijo kostnih vsadkov z izboljšano osteointegracijo**

Dr. Nataša Drnovšek je v okviru doktorskega dela Razvoj prevlek na zlitini Ti6Al4V za novo generacijo kostnih vsadkov z izboljšano osteointegracijo (pod mentorstvom doc. dr. Saše Novak Krmpotič) razvila postopek za nanašanje bioaktivnih prevlek na titanovo zlitino, ki je izboljšal površinske lastnosti vsadka in omogočil hitrejšo in boljšo integracijo kosti v porozen del vsadka. Razvila je tudi postopek sinteze bioaktivnega stekla po partikularni sol-gel metodi, ki je omogočila pripravo delcev nanometrske velikosti z visoko stopnjo bioaktivnosti in ki se lahko enostavno nanašajo v porozne vsadke z vakuumsko infiltracijo. Delo nadaljuje v okviru podoktorskega projekta (2014-2015). Objave: 4 članki v mednarodnih revijah, 3 patenti. Primer: Drnovšek Nataša, Novak Saša, Dragin Urška, Čeh Miran, Gorenšek Matevž, Gradišar Marko. Bioactive glass enhances bone ingrowth into the porous titanium coating on orthopaedic implants. *International Orthopaedics*, 2012, 36, 8, 1739-1745.





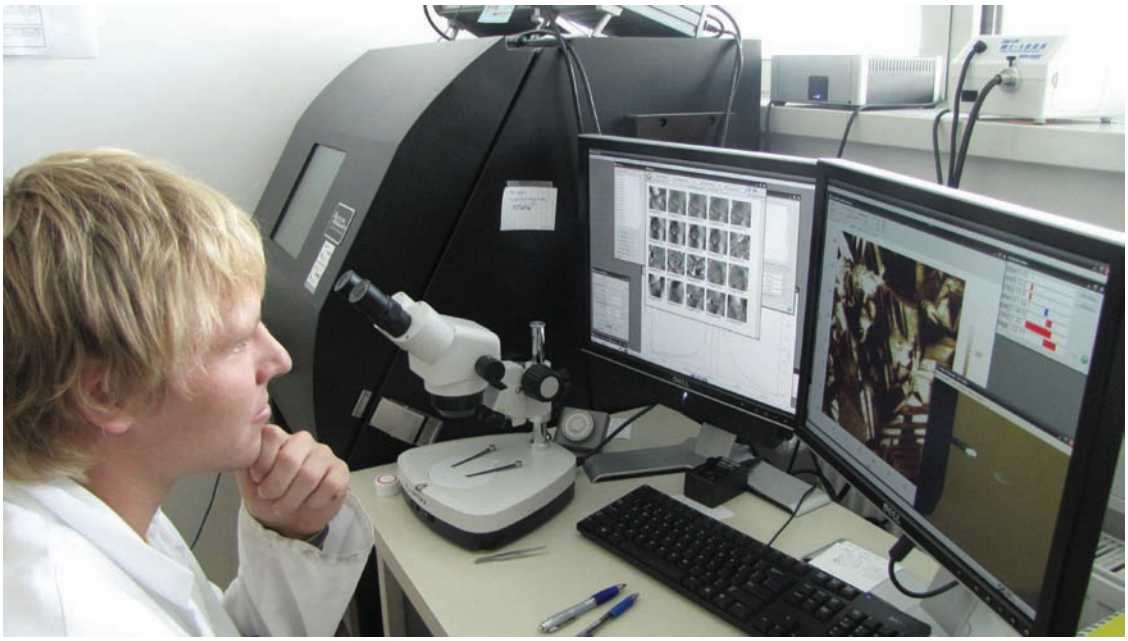
SEM posnetek prereza vzorca Ti zlitine s TiO_2 prevleko (slika desno). Porazdelitev Ca in P v porah in na površini Ti vsadka, ki je bil infiltriran z bioaktivnim steklom, kar ponazarja nastanek nove kosti na površini in po celotnem poroznem delu vsadka (sliki levo).

SEM image of a cross-section of Ti alloy coated hydrothermally with TiO_2 (right). Distribution of Ca and P in the pores on the surface of a Ti implant infiltrated with bioactive glass (left). The distribution of Ca and P represents the formation of new bone on the surface and in the pores of the porous implant.

6.

- ***Development of coatings on a Ti6Al4V alloy for a new generation bone implants with improved osseointegration***

Dr. Nataša Drnovšek *has, during her doctoral dissertation Development of coatings on a Ti6Al4V alloy for a new generation bone implants with improved osseointegration (Supervisor Assistant Professor Saša Novak Krmpotič), developed a method for applying TiO_2 coatings on Ti alloy implants that improved the implant surface properties and enabled faster and better osseointegration of the bone into the porous part of the implant. She also developed the synthesis of bioactive glass using a particulate sol-gel method, which enables the production of bioactive-glass particles in the nanometer range and can thus be easily applied on porous implants by vacuum infiltration. Her work is now continuing as part of a postdoc project in collaboration with Educell d.o.o (2014-2015). Publications: 4 articles in international journals, 3 patents. Example: Drnovšek Nataša, Novak Saša, Dragin Urška, Čeh Miran, Gorenšek Matevž, Gradišar Marko. Bioactive glass enhances bone ingrowth into the porous titanium coating on orthopaedic implants. International Orthopaedics, 2012, 36, 8, 1739-1745.*

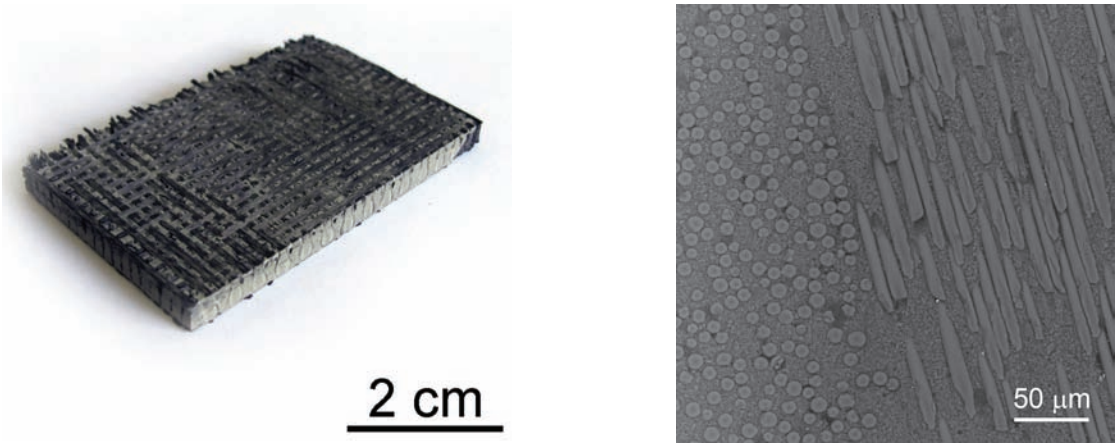


Analiza mikrostrukture z mikroskopom na atomsko silo

Microstructure analysis with Atomic Force Microscope

- **Priprava kompozitnega materiala na osnovi SiC za uporabo v fuzijskem reaktorju**

Dr. Aljaž Iveković je v okviru doktorske disertacije (pod mentorstvom doc. dr. Saše Novak Krmpotič) z naslovom Priprava kompozitnega materiala na osnovi SiC za uporabo v fuzijskem reaktorju pomembno prispeval k razvoju materiala, primernega za uporabo v zahtevnem okolju fuzijskega reaktorja. Kot nov način priprave s SiC vlakni utrjenega SiC kompozita (SiC_f/SiC) z izboljšanimi lastnostmi je uporabil kombiniran proces SITE, ki vključuje infiltracijo tkanine s pomočjo elektroforetskega nanašanja in zgoščevanje matrice z infiltriranjem in pirolizo polimera. Raziskave na področju SiC_f/SiC kompozita (razvitega v času doktorskega usposabljanja) nadaljuje v okviru evropskega projekta *Advanced SiC_f/SiC towards implementation in fusion reactors* (EUROFUSION – Enabling research) kot nosilec projekta. Objave: 8 člankov v mednarodnih revijah (3 z IF nad povprečjem področja), 2 patenta. Primer: Iveković Aljaž, Novak Saša, Dražić Goran, Blagoeva Darina, Gonzalez De Vicente Sehila. Current status and prospects of SiC_f /SiC for fusion structural applications. *Journal of the European Ceramic Society*, 2013, 33, 10, 1577-1589.



3D tkanina iz SiC vlaken, infiltrirana z matrico SiC po postopku SITE (levo), in mikrostruktura poliranega preseka vzorca (desno).

3D fabric of SiC fibers infiltrated with a SiC matrix using the SITE method (left) and the microstructure of a polished cross-section of the sample (right).

- **Vpliv mikrostrukture na visoko koercitivnost Nd-Fe-B magnetov**

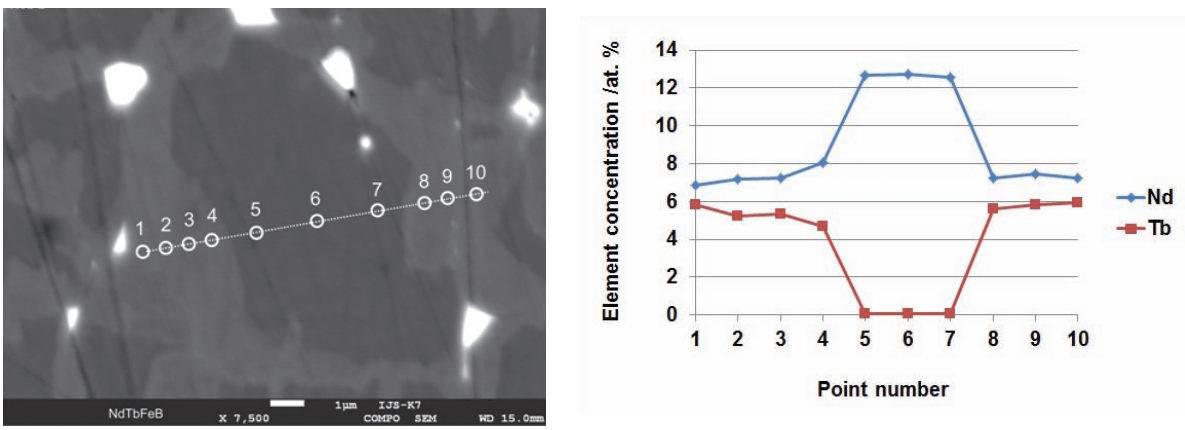
Dr. Marko Soderžnik je v okviru doktorskega dela (pod mentorstvom doc. dr. Paula J. McGuinessa) z naslovom **Razvoj optimalne mikrostrukture tipa »jedro-ovoj« za visoko koercitivne magnete Nd-Fe-B z minimalno vsebnostjo težkih redkih zemelj** pomembno prispeval k reševanju perečega svetovnega problema, ki je zaradi kitajskega embarga na redke zemlje povzročil leta 2010 svetovno krizo. Z elektroforetsko depozicijo in kasnejšo termično obdelavo je dosegel, da je za odlične končne lastnosti Nd-Fe-B magnetov, ki se uporabljajo v električnih in hibridnih vozilih ter vetrnih elektrarnah, potrebna minimalna količina dodane težke redke zemlje. Prihranek pri količini disprozija (Dy) in terbija (Tb) ter s tem finančni prihranek je desetkraten. Dosežek je naletel na izjemno zanimanje svetovne strokovne javnosti (dve vabljeni predavanji na mednarodnih konferencah: 2013 in 2014). Objave: 3 članki v mednarodnih revijah z IF nad povprečjem področja, 2 patenta. Primer: Soderžnik Marko, Žužek Rožman Kristina, Kobe Spomenka, Mcguiness Paul J. The grain-boundary diffusion process in Nd-Fe-B sintered magnets based on the electrophoretic deposition of DyF_3. *Intermetallics*, 2012, 23, 158-162.

- ***Development of a SiC-based composite material for fusion applications***

Dr. Aljaž Iveković, *with his doctoral dissertation (Supervisor Assistant Professor Saša Novak Krmpotič) entitled Development of SiC-based composite material for fusion application, has significantly contributed to the development of a composite material suitable for implementation in the demanding environment of a fusion reactor. A novel process, named SITE, was developed for the fabrication of SiC fibre-reinforced SiC-matrix composite material (SiC_f/SiC) with improved properties. The process combines the infiltration of a fabric preform by an electrophoretic (infiltration) deposition (EP(I)D) process with densification by polymer infiltration and a pyrolysis process (PIP). The research on the SiC_f/SiC composite developed within the framework of his doctoral training is being continued under his leadership within a European project entitled Advanced SiC_f/SiC towards implementation in fusion reactors (EUROFUSION – Enabeling research). Publications: 8 articles in international publications (3 with with above-average IF), 2 patents. Example: Iveković Aljaž, Novak Saša, Dražić Goran, Blagoeva Darina, Gonzalez De Vicente Sehila. Current status and prospects of SiC_f/SiC for fusion structural applications. Journal of the European Ceramic Society, 2013, 33, 10, 1577-1589.*

- ***Influence of microstructure on high-coercivity Nd-Fe-B magnets***

With a systematic approach using electrophoretic deposition (EPD) and the-grain boundary diffusion process (GBDP), ***Dr. Marko Soderžnik*** *made a great impact in his contribution to solving the world rare-earth crisis caused by supply problems. In his doctoral dissertation (Supervisor Assistant Professor Paul J. McGuiness) entitled* ***The development of an optimum core-shell microstructure for high-coercivity Nd-Fe-B magnets with minimum heavy-rare-earth content****, he achieved a 30 % improvement of coercivity with a ten times smaller amount of heavy rare earth (Dy, Tb). The addition of heavy rare earth contributes to higher coercivities, but due to the antiferromagnetic coupling between Fe and Dy this simultaneously decreases the magnetization. By using EPD and GBDP he managed to tailor the core-shell microstructure, and increase the coercivity to the level which is needed for applications in electric and hybrid vehicles and wind turbines. The decrease of magnetization was negligible. His results were well received by the international magnet community (two invited talks at international conferences: 2013 and 2014). Publications: 3 papers in journals with above average IF, 2 patents. Example: Soderžnik Marko, Žužek Rožman Kristina, Kobe Spomenka, Mcguiness Paul J. The grain-boundary diffusion process in Nd-Fe-B sintered magnets based on the electrophoretic deposition of DyF_3. Intermetallics, 2012, 23, 158-162.*

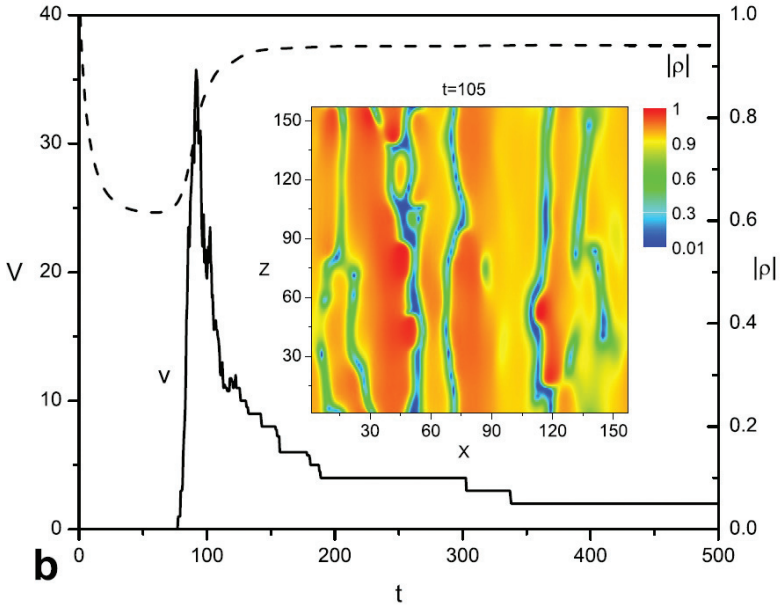


Mikrostruktura vzorca z 0,2 mol. % dodanega Tb, ki predstavlja »jedro-ovoj« in pripadajoča linijska EDS analiza.

A representative core-shell microstructure and the corresponding EDS analysis of a Nd-Fe-B sample with 0.2 mol. % Tb.

- **Pojav faznega zdrsa in dinamika vrtincev v mezoskopskih superprevodnikih**

Gibanje in nastanek vrtincev zaradi različnih motenj je že več desetletij zanimivo področje raziskav. V doktorski disertaciji Pojav faznega zdrsa in dinamika vrtincev v mezoskopskih superprevodnikih, ki jo je izdelal **dr. Mathieu Lu-Dac** (mentor prof. dr. Viktor Kabanov) so opisani različni tipi pojava faznega zdrsa in nastanka vrtincev zaradi različnih oblik motenj, med drugim tudi nastanek vrtinca po Kelvin-Helmholtzovem mehanizmu. Delo o kaotični dinamiki vrtincev je bilo objavljeno v reviji Physical Review Letters. Objave: 5 člankov v revijah z recenzijo. Primer: Lu-Dac Mathieu, Kabanov Viktor V. Phase slip phenomena in superconductors: from ordered to chaotic dynamics. *Physical Review Letters*, 2010, 105, 15, 157005-1-157005-4.



Kaotično gibanje vrtincev v superprevodnih filmih v obliki »rek vrtincev«.

Chaotic motion of vortices in the superconducting film in the form of »vortex rivers«.

- **Nova sintezna pot za pripravo materialov na osnovi $Pb(Mg_{1/3}Nb_{2/3})O_3$ s kontrolirano aglomeracijo delcev reagentov**

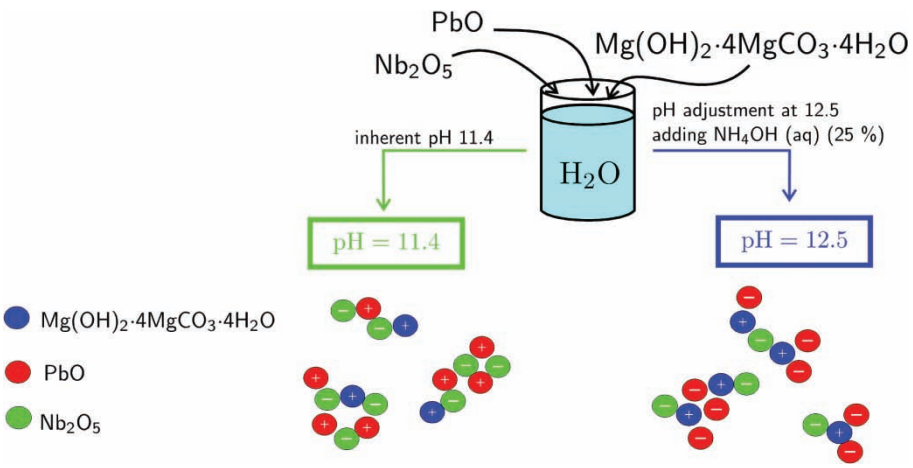
Dr. Gregor Trefalt je v okviru doktorske disertacije Nova sintezna pot za pripravo materialov na osnovi $Pb(Mg_{1/3}Nb_{2/3})O_3$ s kontrolirano aglomeracijo delcev reagentov (mentorici prof. dr. Marija Kosec in prof. dr. Bosiljka Tadić) raziskal in razvil novo metodo sinteze kompleksnih oksidov v trdnem stanju, ki temelji na načrtovanju stikov med delci reagentov v vodnih suspenzijah, kar je nov pristop k sintezi v trdnem stanju v svetovnem merilu. Hipotezo je preveril z modeliranjem mehanizma aglomeracije v suspenzijah in v nadaljevanju z eksperimentalno verifikacijo. Kot modelni sistem je raziskal $Pb(Mg_{1/3}Nb_{2/3})O_3$. Objave: 7 člankov. Primer: Trefalt Gregor, Tadić Bosiljka, Kosec Marija. Formation of colloidal assemblies in suspensions for $Pb(Mg_{1/3}Nb_{2/3})O_3$ synthesis: Monte Carlo simulation study. *Soft Matter*, 2011, 7, 12, 5566-1-5566-12.

- ***Phase slip phenomena and vortex dynamics in mesoscopic superconductors***

The investigation of the motion of vortices and the generation of vortices by different perturbations has been an intriguing branch of research for decades. The doctoral dissertation Phase slip phenomena and vortex dynamics in mesoscopic superconductors of ***Dr. Mathieu Lu-Dac*** *(Supervisor Associate Professor Viktor Kabanov) describes different types of phase slip phenomena and vortex production using different types of perturbations, including vortex generation using the Kelvin-Helmholtz mechanism. The work on the chaotic dynamics of vortices was published in Physical Review Letters. Publications: 5 papers in refereed journals. Example: Lu-Dac Mathieu, Kabanov Viktor V. Phase slip phenomena in superconductors: from ordered to chaotic dynamics. Physical Review Letters, 2010, 105, 15, 157005-1-157005-4.*

- ***A New Synthesis Route to $Pb(Mg_{1/3}Nb_{2/3})O_3$-Based Materials by the Controlled Agglomeration of Reagent Particles***

In his doctoral dissertation A New Synthesis Route to $Pb(Mg_{1/3}Nb_{2/3})O_3$-Based Materials by the Controlled Agglomeration of Reagent Particles, ***Dr. Gregor Trefalt*** *(Supervisors Professor Marija Kosec and Professor Bosiljka Tadić) researched and developed a new method for the synthesis of complex oxides in the solid state, which is based on planning contacts between reagent particles in water suspensions. This is a new approach to synthesis in the solid state. The hypothesis was verified by modelling the agglomeration mechanism in suspensions and later on by experimental verification. As a model system he researched $Pb(Mg_{1/3}Nb_{2/3})O_3$. Publications: 7 articles. Example: Trefalt Gregor, Tadić Bosiljka, Kosec Marija. Formation of colloidal assemblies in suspensions for $Pb(Mg_{1/3}Nb_{2/3})O_3$ synthesis: Monte Carlo simulation study. Soft Matter, 2011, 7, 12, 5566-1-5566-12.*



Sinteza kompleksnih oksidov s kontrolirano aglomeracijo delcev reagentov.

Synthesis of complex oxides by the controlled agglomeration of reagent particles.

- **Kontrolirana sinteza TiO_2 nanodelcev in njihova uporaba v fotovoltaiki**

Dr. Dejan Verhovšek je v okviru doktorskega dela (mentor prof. dr. Miran Čeh) Kontrolirana sinteza TiO_2 nanodelcev in njihova uporaba v fotovoltaiki razvil in optimiziral številne postopke za sintezo nanodelcev TiO_2 z uporabo surovin Cinkarne Celje d.d. Kontrolirano je sintetiziral nanodelce z rutilno strukturo z velikostjo 60–160 nm ter delce z anatasno strukturo z velikostjo 40–50 nm. S hidrotermalno sintezo je pripravil sferične monokristalne delce TiO_2 s strukturo anatasa in z velikostjo 30 nm. Porozne anode za DSSC (Dye-Sensitised Solar Cell) celice je pripravljal po Pecchinijevi metodi. Meritve izkoristkov izdelanih DSSC sončnih celic so pokazale vrednosti do 2,3 %. Za fotokatalitične prevleke je uporabil polikristalinične nanodelce TiO_2 z anatasno strukturo. Na osnovi izsledkov svojih raziskav je v Cinkarni Celje uspešno vpeljal proizvodnjo nanokristaliničnega titanovega dioksida v industrijskem obsegu. Objave: 4 članki, 3 patenti, 2 patentni prijavi. Primer: Verhovšek Dejan, Gominšek Tomi, Čeh Miran, Blagotinšek Pavel, Šturm Sašo, Žagar Kristina. Nanodelci anatasa in postopek sinteze za pridobivanje nanodelcev anatasa: SI 23219 (A), 2011-05-31. Ljubljana: Urad Republike Slovenije za intelektualno lastnino, 2011.

(a) TEM posnetek sintetiziranih anatasnih nanodelcev, (b) stekleni substrat s samočistilnim nanosom na osnovi TiO_2, (c) prikaz hidrofilnega efekta

(a) TEM image of anatase nano particles, (b) glass substrate with self-cleaning coating based on TiO_2, (c) hydrophilic effect

- **Struktura in karakterizacija 0,65PMN-0,35PT debelih plasti na različnih podlagah**

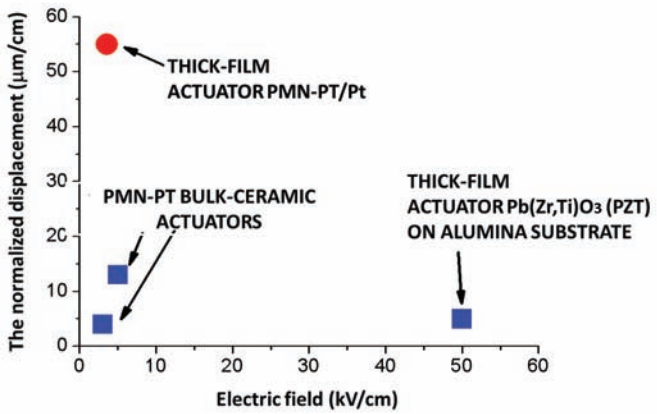
Dr. Hana Uršič Nemevšek je v okviru doktorske disertacije Strukturna in električna karakterizacija 0,65PMN-0,35PT debelih plasti na različnih podlagah (mentorica prof. dr. Marija Kosec) dokazala, da lahko na lastnosti piezoelektričnih debeloplastnih struktur $0{,}65Pb(Mg_{1/3}Nb_{2/3})O_3–0{,}35PbTiO_3$ (0,65PMN–0,35PT) vplivamo z mehanskimi napetostmi, ki so posledica različnih termičnih raztezkov plasti in podlage. S sodelavci je razvila nov postopek priprave prosto stoječih aktuatorjev 0,65PMN–0,35PT z zelo velikim odmikom. Odmik na enoto dolžine aktuatorja 55 µm/cm pri električnem polju 3,6 kV/cm je približno petkrat večji kot pri aktuatorjih, pripravljenih iz volumenske keramike PMN–PT, ali debeloplastnih aktuatorjih na korundnih podlagah, o katerih poročajo v literaturi. Objave: 6 člankov, pregledni članek in 2 poglavji v knjigi. Primer: Uršič Hana, Hrovat Marko, Holc Janez, Santo-Zarnik Marina, Drnovšek Silvo, Maček Srečo, Kosec Marija. A large-displacement $65Pb(Mg_{1/3}Nb_{2/3})O_3$-$35PbTiO_3$/Pt bimorph actuator prepared by screen printing. *Sensors and Actuators*. B, Chemical, 2008, 133, 2, 699-704.

- ***Controlled synthesis of TiO_2 nanoparticles and their application in photovoltaics***

In his doctoral dissertation Controlled synthesis of TiO_2 nanoparticles and their application in photovoltaics Dr. Dejan Verhovšek (Supervisor Associate Professor Miran Čeh) developed and optimized numerous procedures for the synthesis of TiO_2 particles by using raw materials provided by Cinkarna Celje. Under controlled conditions he synthesized nanoparticles with a rutile structure of size of 60–160 nm and particles of anatase structure of size 40–50 nm. Using a hydrothermal synthesis he prepared spherical monocrystal particles of TiO_2 with the anatase structure and a size of 30 nm. Porous anodes for DSSC cells were prepared by the Pecchini method. Measurements of the efficiency of the DSSC (Dye-Sensitised Solar Cell) solar cells showed values up to 2.3 %. For the photocatalitic coating he used polycrystalline TiO_2 nanoparticles with the anatase structure. On the basis of the results of his research he successfully introduced to Cinkarna Celje the production of nanocrystallinic TiO_2 on an industrial scale. Publications: 4 articles, 3 patents, 2 patent applications. Example: Verhovšek Dejan, Gominšek Tomi, Čeh Miran, Blagotinšek Pavel, Šturm Sašo, Žagar Kristina. Nanodelci anatasa in postopek sinteze za pridobivanje nanodelcev anatasa: SI 23219 (A), 2011-05-31. Ljubljana: Urad Republike Slovenije za intelektualno lastnino, 2011.

- ***Structure and characterisation of 0.65PMN-0.35PT thick films on different substrates***

In her doctoral dissertation Structural and electrical properties of 0.65PMN-0.35PT thick films on different substrates ***Dr. Hana Uršič Nemevšek*** *(Supervisor Professor Marija Kosec) proved that the properties of piezoelectric thick-layered structures $0.65Pb(Mg_{1/3}Nb_{2/3})O_3–0.35PbTiO_3$ (0.65PMN–0.35PT) can be influenced by mechanical stresses that are the result of different thermic expansions of the layer and substrate. With her collaborators she developed a new procedure for the preparation of large-displacement substrate-free, bending-type actuators 0.65PMN–0.35PT. The displacement per actuator unit length of 55 µm/cm at an electric field of 3.6 kV/cm is approximately five times larger than for actuators prepared from volume ceramics bulk PMN-PT or thick-film actuators on corundum substrates that have been reported in the literature. Publications: 6 articles, review article and two book chapters. Example: Uršič Hana, Hrovat Marko, Holc Janez, Santo-Zarnik Marina, Drnovšek Silvo, Maček Srečo, Kosec Marija. A large-displacement $65Pb(Mg_{1/3}Nb_{2/3})O_3$-$35PbTiO_3$/Pt bimorph actuator prepared by screen printing. Sensors and Actuators. B, Chemical, 2008, 133, 2, 699-704.*

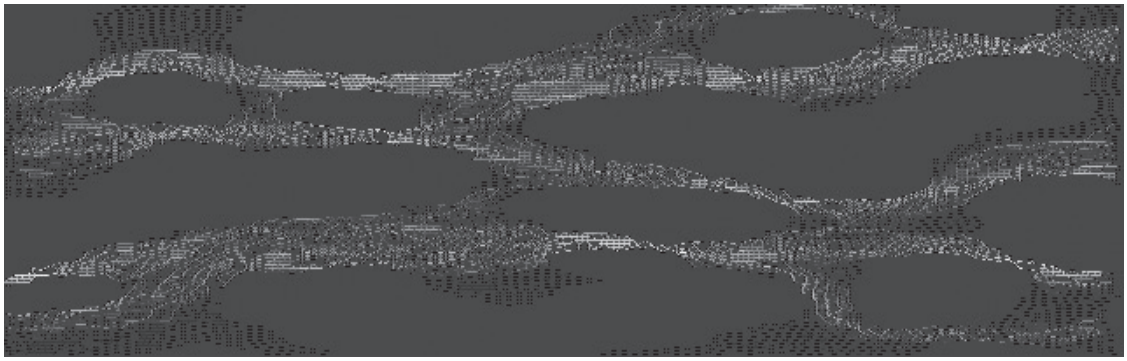


Odmik aktuatorja PMN–PT/Pt, normaliziran na dolžino v odvisnosti od električnega polja (originalno delo: rdeč krog, ostala literatura: modri kvadrati).

Displacement of the 0.65PMN-0.35PT actuator per unit length versus applied electric field (red circle: original work, blue squares: literature data).

- **Modeliranje samourejenih funkcionalnih materialov s pomočjo teorije omrežij**

Samourejanje nanodelcev v skupke različnih struktur predstavlja obetaven način za ustvarjanje nanomaterialov, ki kažejo nove funkcionalne lastnosti na višji ravni. Doktorsko delo **dr. Milovana Šuvakova** z naslovom Modeliranje samourejenih funkcionalnih materialov s pomočjo teorije omrežij (mentorica prof. dr. Bosiljka Tadić) obravnava teoretično modeliranje nelinearnih procesov samourejanja in študij prevodnosti nanodelčnih filmov na substratih. S pomočjo mapiranja na matematični graf so razviti modeli eno-elektronskega tuneliranja skozi film poljubne strukture. Poleg ustrezne interpretacije eksperimentalnih meritev so izboljšane prevodnosti filmov s topološko neurejenostjo, numerične simulacije poti posameznih elektronov pa zagotavljajo razumevanje fenomena kolektivnega transporta naboja v nanomaterialih. Objave: 7 člankov v revijah z SCI, med drugim v reviji Nano Letters. Primer: Blunt Matthew O., Šuvakov Milovan. Charge Transport in Cellular Nanoparticle Networks: Meandering through Nanoscale Mazes. *Nano Letters*, 2007, 7, 4, 855–860.



Vizualizacija poti elektronov v procesih eno-elektronskega tuneliranja skozi nanodelčni film v numeričnih simulacijah

Visualisation of the electron paths in single-electron tunneling processes through the nanoparticle film, captured by numerical simulations

- **Tekočekristalne mikrokapljice kot optični mikroresonatorji in laserji**

V integriranih vezjih prihodnosti bo zelo verjetno električni tok nadomeščen s svetlobo, tok fotonov pa bo nadzorovan s fotoni. Doktorsko delo **dr. Matjaža Humarja** z naslovom **T**ekočekristalne mikrokapljice kot optični mikroresonatorji in laserji (mentor prof. dr. Igor Muševič) posega na področje fotonike na nekonvencionalen način, saj kot prvi raziskuje uporabo mikrokapljic tekočih kristalov za optične mikroresonatorje in laserje. Med najodmevnejšimi dosežki njegovega doktorskega dela je odkritje optičnih resonanc (Whispering-Gallery Modes) v nematskih kapljicah in 3D mikrolaserja na osnovi kiralnih nematskih tekočih kristalov. Objave: 5 člankov v revijah z SCI, 2 patentni prijavi. Primer: Humar Matjaž, Ravnik Miha, Pajk Stane, Muševič Igor. Electrically tunable liquid crystal optical microresonators. *Nature Photonics*, 2009, 3, 10, 595-600.

- ***Modelling of self-assembled functional materials using the theory of networks***

The self-assembly of nanoparticles into clusters of different structures represents a promising way to create nano-materials that show new functional properties on a higher level. The doctoral dissertation Modelling of self-assembled functional materials using the theory of networks of ***Dr. Milovan Šuvakov*** *(Supervisor Professor Bosiljka Tadić) deals with the theoretical modelling of nonlinear processes of self-regulation and conductivity studies of nanoparticle films on substrates. Using mapping to a mathematical graph, he developed models for single-electron tunnelling through films of arbitrary structures. Apart from providing an interpretation of the experimental data on the conductivity of films with topological disorder, numerical simulations of the paths of individual electrons provide an understanding of the phenomenon of collective charge transport in nanomaterials. Publications: 7 articles in SCI journals, including Nano Letters. Example: Blunt Matthew O., Šuvakov Milovan. Charge Transport in Cellular Nanoparticle Networks: Meandering through Nanoscale Mazes. Nano Letters, 2007, 7, 4, 855–860.*

- ***Liquid-crystal microdroplets as optical micro-resonators and lasers***

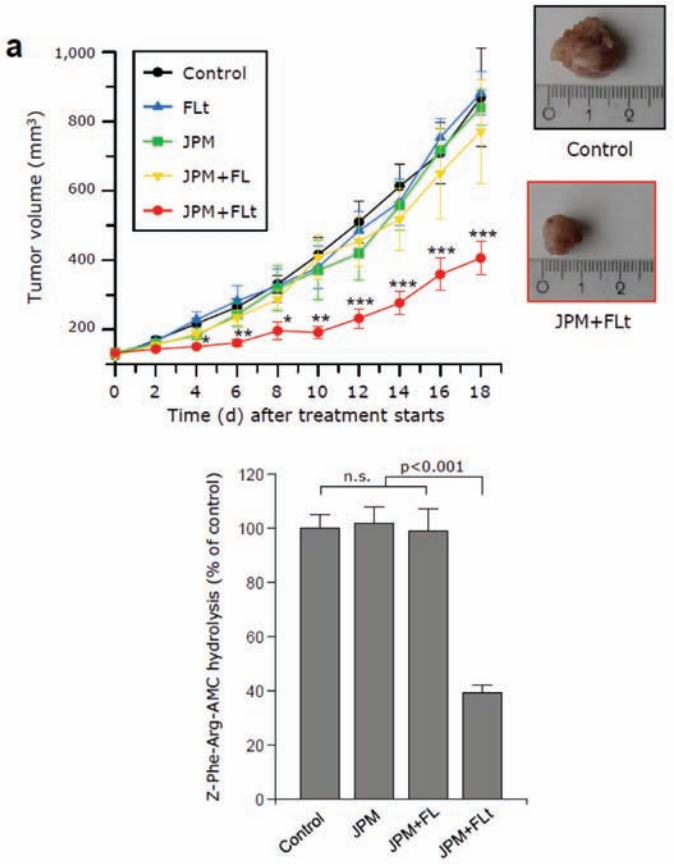
In integrated circuits in the future it will be very likely that electric currents are replaced with light, where the photon flux will be controlled by photons. The doctoral dissertation Liquid-crystal microdroplets as optical micro-resonators and lasers of ***Dr. Matjaž Humar*** *(Supervisor Professor Igor Muševič) reaches into the field of photonics in an unconventional way, as a first exploration of the use of microdroplets of liquid crystals for optical and laser microresonators. Among the most notable achievements of his doctoral dissertation is the discovery of optical resonances called Whispering-Gallery Modes in nematic drops, and a 3D microlaser based on chiral nematic liquid crystals. Publications: 5 articles in SCI journals, 2 patent applications. Example: Humar Matjaž, Ravnik Miha, Pajk Stane, Muševič Igor. Electrically tunable liquid crystal optical microresonators. Nature Photonics, 2009, 3, 10, 595-600.*

Slika z naslovnice revije ponazarja laserski mikrorezonator.

A journal cover depicting an optical laser microresonator.

- **Razvoj ciljanih nanodostavnih sistemov za zdravila**

Razvoj novih dostavnih sistemov za ciljano dostavo zdravil na osnovi nanodelcev je področje, ki je v zadnjem času doživelo izreden razvoj, kajti takšni sistemi lahko bistveno zmanjšajo toksičnost potencialnih zdravil in izboljšajo njihovo biodostopnost. Doktorsko delo **Razvoj novih nanoprenašalcev za tarčno dostavo in diagnostiko Georgya Mikhaylova** (mentor prof. ddr. Boris Turk) obravnava razvoj dveh različnih dostavnih sistemov za zdravila: enega pasivnega, ki temelji na železo-oksidnih nanodelcih, enkapsuliranih v liposome, in magnetnem tarčenju, ter enega aktivnega, ki temelji na ligandu proteaz, vsidranem v liposome. Oba sistema sta bila uspešno preizkušena in vivo na živalskem modelu raka. Razvoj dostavnega sistema na osnovi feriliposomov, pri razvoju katerega je ključno sodeloval Georgy Mikhaylov, je bil objavljen v reviji Nature Nanotechnology. Objavljena ima dva članka v SCI (Nature Nanotech., Biol. Chem.), eden pa je bil sprejet v tisk (Angew. Chem. Intl. Ed.), v vseh je prvi avtor. Ima tudi ruski patent in dve patentni prijavi. Primer: Mikhaylov Georgy (Pisar), Mikac Urška, Magaeva Anna A., Itin Volia Isaevich, Naiden Evgeniy P., Psakhye Ivan Sergeevich, Babes Liane, Reinheckel Thomas, Peters Christoph, Zeiser Robert, Bogyo Matthew, Turk Vito, Psahkye Sergej G., Turk Boris, Vasiljeva Olga. Ferri-liposomes as an MRI-visible drug-delivery system for targeting tumours and their microenvironment. *Nature Nanotechnology*, 2011, 6, 9, 594-602.



Uspešna dostava zaviralca proteaz s pomočjo magnetnega tarčenja feriliposomov je bistveno izboljšala njegovo učinkovitost in pomembno zavrla rast tumorja v mišjem modelu raka.

Successful delivery of a protease inhibitor using magnetic targeting of ferriliposomes containing an inhibitor largely improved its efficacy and substantially delayed the tumor growth in a mouse-cancer model.

- ***Development of targeted nano-carrier systems for drug delivery***

The development of novel drug-delivery systems on the basis of nanoparticles is a field that has dramatically advanced in recent years. The major reason is that such systems can greatly diminish the toxicity of potential drugs and/or substantially improve their bioavailability. The doctoral dissertation ***Development of a novel nano-carriers for targeted drug delivery and diagnostics*** *of* ***Georgy Mikhaylov*** *(Supervisor Professor Boris Turk) deals with the development of two different drug-delivery systems, one based on iron-oxide nanoparticles encapsulated in liposomes, which enables passive magnetic targeting, and the second, which is based on a protease ligand, anchored in the liposomes, enabling active targeting. Both systems have been successfully validated in vivo in a mouse-cancer model. The development of the ferriliposome-based delivery system, where Georgy played a key role, was published in the journal Nature Nanotechnology. He published two papers indexed in SCI (Nature Nanotech., Biol. Chem.), whereas one was just accepted (Angew. Chem. Intl. Ed.). He is the first author of all papers. In adition, he is co-author of one Russian patent (granted) and two patent applications.*
Example: Mikhaylov Georgy (Pisar), Mikac Urška, Magaeva Anna A., Itin Volia Isaevich, Naiden Evgeniy P., Psakhye Ivan Sergeevich, Babes Liane, Reinheckel Thomas, Peters Christoph, Zeiser Robert, Bogyo Matthew, Turk Vito, Psahkye Sergej G., Turk Boris, Vasiljeva Olga. Ferri-liposomes as an MRI-visible drug-delivery system for targeting tumours and their microenvironment. Nature Nanotechnology, 2011, 6, 9, 594-602.

Študent MPŠ določa proteinsko mikrokalorimetrijo, ki temelji na meritvah toplote, ki se sprosti ali porabi v interakciji med proteini in ligandi.

IPS student determines protein microcalorimetry based on measurements of heat that is released or consumed during the interaction between protein and ligand.

KAJ PRAVIJO NANOTEHNOLOGI – ALUMNI MPŠ?

Dr. Dejan Verhovšek
Koordinator, Služba za raziskave in razvoj
Cinkarna Celje

Trenutno je eden izmed večjih izzivov in hkrati problemov slovenske znanosti in industrije zagotovo učinkovit prenos znanja z univerz in inštitutov na industrijsko-proizvodno raven. Na vedno bolj kompetitivnem globalnem trgu je potrebno danes bolj kot kdajkoli prej stremeti k razvoju materialov in končnih izdelkov visoke dodane vrednosti, saj lahko le to, dolgoročno gledano, omogoča gospodarsko rast in hkrati nadaljnja vlaganja sredstev v znanstvene raziskave.

Dobro sodelovanje znanstvene inštitucije in industrije podpirajo zlasti pobude v obliki razpisov, kakršen je bil razpis za mlade raziskovalce iz gospodarstva, na katerega sem se pod okriljem Cinkarne Celje in Instituta »Jožef Stefan« (IJS) pod mentorstvom prof. dr. Mirana Čeha uspešno prijavil ter začel doktorski študij na Mednarodni podiplomski šoli Jožefa Stefana (MPŠ). Izbral sem smer Nanoznanosti in nanotehnologije, saj je okvirni študijski program tematsko sovpadal z raziskovalnim delom doktorskega študija, ki je bil usmerjen v razvoj nanodelcev titanovega dioksida (TiO_2) v obliki vodnih suspenzij in v razvoj nano-TiO_2 vezanih aplikacij na področju fotovoltaike.

Izbrana študijska smer na MPŠ mi je podala potrebno teoretično ozadje in s tem podlago za načrtovanje eksperimentalnega dela, izvedenega v laboratorijih Cinkarne Celje. V sodelovanju med IJS in Cinkarno se je razvilo zelo dobro sodelovanje na področju karakterizacije pridobljenih nanomaterialov. V okviru MPŠ je bil zagotovljen teoretični temelj, ki je omogočal razumevanje in posledično spreminjanje reakcijskih parametrov. Tako smo nanodelcem TiO_2 spreminjali kristalno strukturo (rutil ali anatas), kristaliničnost in velikost delcev.

Zelo pomembno je bilo, da je Cinkarna Celje opredelila cilj tega raziskovalnega dela: stremeti k razvoju nano-TiO_2 z uporabo v podjetju dosegljivih materialov in surovin, z lastno tehnologijo in ob upoštevanju za podjetje določenih ekonomskih ter ekoloških omejitvenih faktorjev.

Med študijem je uspelo razviti različne sintezne metode pridobivanja nanodelcev TiO_2, zasnovati potrebno teoretično ogrodje za razumevanje reakcij, preizkusiti materiale v samočistilnih premazih za fotovoltaične module ter v fotoelektrokemijskih sončnih celicah. Prav tako zelo pomembno pa je dejstvo, da smo delo načrtovali v tesnem sodelovanju IJS in MPŠ z matičnim podjetjem, kar je omogočilo učinkovit prenos znanja v industrijsko proizvodnjo. Tako je Cinkarna Celje danes edino slovensko podjetje z lastnim znanjem in tehnologijo za proizvodnjo industrijskih količin nano-TiO_2, ki je zaradi svojih izrednih kemijsko-fizikalnih lastnosti material za številne visoko-tehnološke aplikacije, ki segajo od fotokatalize do zajema UV sevanja za zaščito različnih substratov.

Sam vidim tak način sodelovanja med industrijo in znanstvenimi inštitucijami, kot sem ga bil deležen med svojim doktorskim študijem, kot ključen za prenos znanja v proizvodnjo. To pa je tudi edini način za učinkovito vračanje sredstev, vloženih v raziskave in razvoj, v korist gospodarstva in celotne družbe.

Naj posebej izpostavim vso pomoč, ki sem je bil deležen na IJS, MPŠ in zlasti od svojega mentorja prof. dr. Mirana Čeha ter matičnega podjetja, saj so mi nudili trdno podporo za doseganje vrhunskega teoretskega znanja, potrebnega za dosego znanstvenega naziva in neposredno uporabnega razvojnega znanja za osnovanje proizvodnje nano-TiO_2 v Cinkarni Celje, od katerega si lahko podjetje upravičeno obeta bolj kompetitiven nastop na svetovnem trgu.

WHAT NANOTECHNOLOGISTS HAVE TO SAY – IPS ALUMNI?

Dr. Dejan Verhovšek

Research Area Coordinator, Research & Development Sector

Cinkarna Celje

One of the major challenges and problems facing current Slovenian science and industry is the efficient transfer of knowledge from the universities and institutes to the industrial-production sector. Since the global market is becoming ever more competitive, it is nowadays, more than ever before, crucial to focus on the development of materials and end-products with a high added value to ensure economic growth and future investments into a variety of scientific activities.

The basis for achieving this goal is a well-organized collaboration between the scientific institutions and the industry sector. Such a cooperation is possible with the appropriate incentives, such as the »call for young researchers in the industry sector«, which was successfully addressed by Cinkarna Celje and the Jožef Stefan Institute (JSI), and enabled me to start my doctoral studies at the Jožef Stefan International Postgraduate School (IPS) under the supervision of Associate Professor Miran Čeh. The curriculum chosen was Nanosciences and Nanotechnologies, which coincided well with the scientific research activities of my studies, focused on developing TiO_2 nanoparticles in the form of a water suspension and the subsequent development of photovoltaic-based applications.

The chosen IPS curriculum gave me the necessary theoretical background and thus the basis to plan the experimental work, which was carried out in Cinkarna Celje's laboratories. A well-organized cooperation between the JSI and Cinkarna Celje enabled a comprehensive characterisation and analysis of the produced nanomaterials. The IPS provided me with the theoretical background, which was the basis for me to understand and therefore influence the various reaction parameters. This enabled us to control the crystal structure (rutile or anatase), the crystallinity and the particle size of the prepared nanoparticles.

Very importantly, Cinkarna Celje provided the final goal of the research activities, i.e., to focus on developing nano-TiO_2, by only using the company's own raw materials and technologies and complying with the economic and ecological limitations.

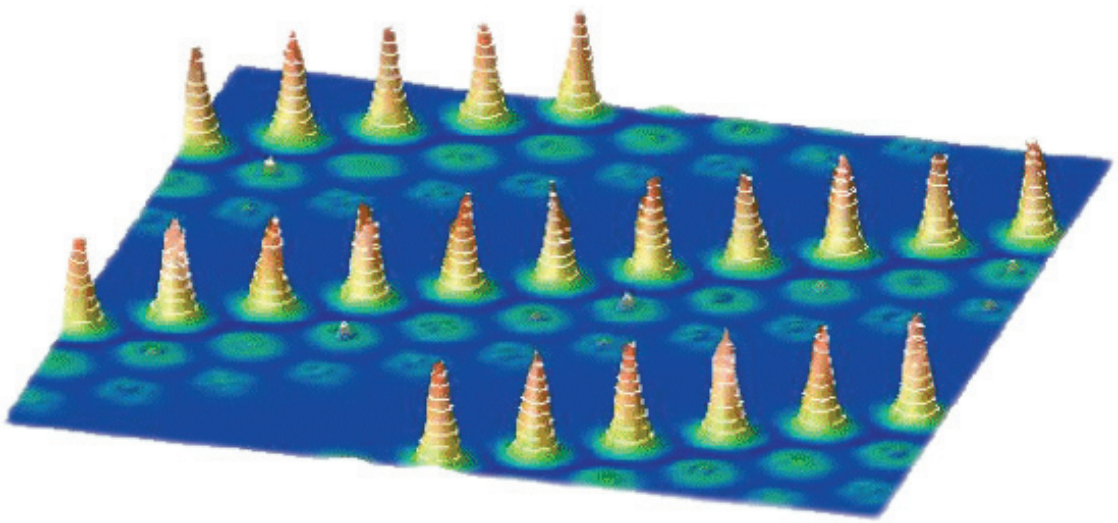
During the course of my studies we successfully developed various synthesis routes for nano-TiO_2 materials, provided the theoretical background to understand the underlying reaction mechanisms and tested the final materials in self-cleaning, photocatalytically active coatings for PV modules and dye-sensitized solar cells (DSSCs). The work was carefully planned with both partners, the JSI and the IPS, closely collaborating with Cinkarna Celje, which enabled the efficient transfer of the gained knowledge into the scale-up industrial production of nano-TiO_2. Consequently, Cinkarna Celje became the sole Slovenian company with owen know-how and technology to produce industrial-scale quantities of nano-TiO_2 material, which, based on its unique chemical and physical properties, can be used for various high-technology applications, which range from photocatalysis to UV absorption of the incident radiation, so enabling the protection of various substrates.

The type of cooperation between the industry sector and the research institutes that I experienced during my doctoral studies is, in my opinion, crucial to enable the effective transfer of knowledge to industry. This is also the only way that enables the effective reimbursement of the funds provided for the research and development activities, which therefore benefits the economy and society, overall.

I would like to highlight all the help provided by the JSI, IPS, my supervisor Associate Professor Miran Čeh and Cinkarna Celje, since they provided the strong support that enabled me to attain the original theoretical background needed to finish my doctoral studies and to directly transfer it into developing the nano-TiO_2 production capacities in Cinkarna Celje, which will economically benefit the company and enable it to become more competitive on the global market.

Dr. Ljupka Stojčevska
Podoktorska sodelavka na Institutu »Jožef Stefan«

Najpomembnejša značilnost Mednarodne podiplomske šole Jožefa Stefana je, da so predavatelji vsi po vrsti člani priznanih in uglednih univerz, ki pri svojih predavanjih poudarjajo tudi uporabo znanstvenih dosežkov. S tem nam pomagajo razvijati raziskovalne spretnosti, ki so ključne ne samo za uspešno delovanje v raziskovalni sferi, ampak tudi za kakovostno delo v gospodarskem okolju. Tako je šolanje na MPŠ odlična odskočna deska za mladega raziskovalca z zelo visokimi ambicijami glede svoje kariere.

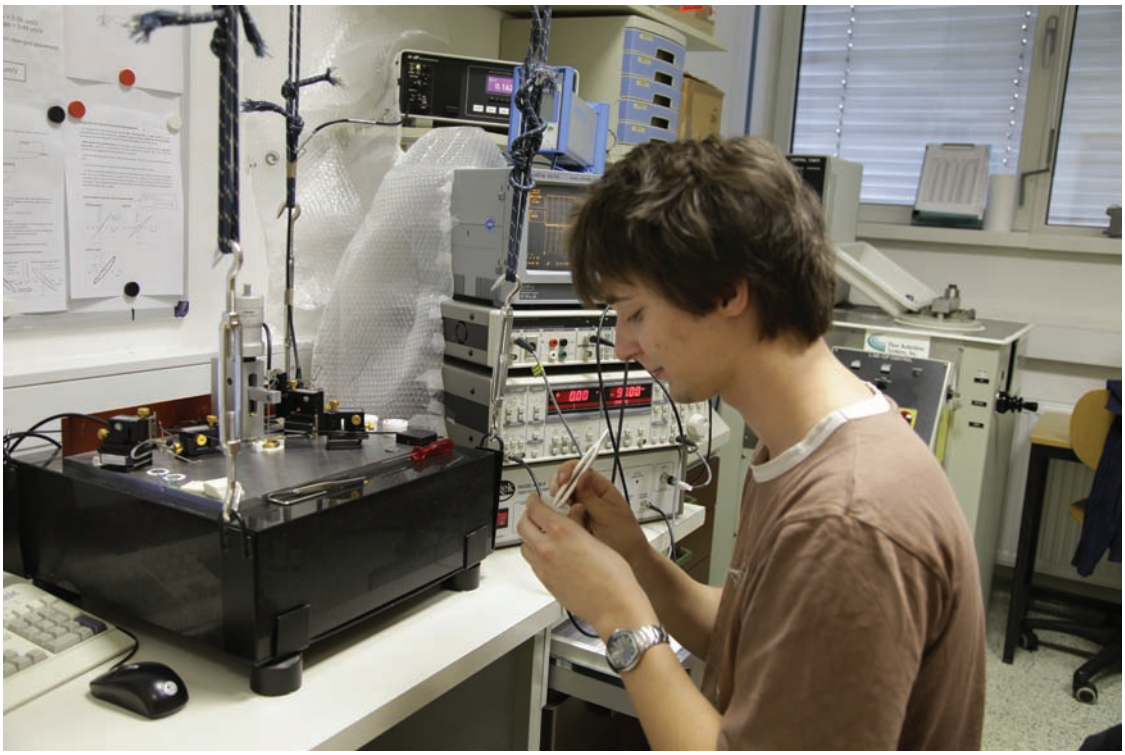


Izračunana gostota spinov kaže na prisotnost inducirane magnetizacije v Pt podlagi.
Calculated spin density reveals the presence of the induced magnetization in the Pt substrate.

Dr. Ljupka Stojčevska

Postdoctoral researcher at the Jožef Stefan Institute

The most important feature of the Jožef Stefan International Postgraduate School is that its lecturers are members of recognized and reputable universities who emphasise the application of scientific disciplines. This helped us to develop research skills that are crucial not only for successful operation in the research community, but also for successful work in an industrial environment. Studying at the IPS is a perfect springboard for young researchers with very high ambitions in their career.



Meritev deformacije pod vplivom električnega polja s senzorjem z optičnim vlaknom

Measurement of electric-field induced strain with an optical-fiber sensor

POGLED NAZAJ – KDO KAŽE POT NAPREJ?

Prof. dr. Marija Kosec (1947 – 2012)

Podpredsednica Mednarodne podiplomske šole Jožef Stefan

Ime prof. dr. Marije Kosec, profesorice MPŠ v programu Nanoznanosti in nanotehnologije, je vklesano v zgodovino naše šole, ki jo je pomagala graditi z upornostjo in nalezljivim veseljem.

Pravzaprav bi lahko rekli, da je bila dvojna osebnost. Po eni strani zelo resna vrhunska raziskovalka, ki je znala misliti in garati in je svoje dosežke na področju elektronske keramike objavila v stotinah člankov, več tisočkrat citiranih. Vodila je na desetine zahtevnih mednarodnih projektov ter organizirala in vodila številne uspešne raziskovalne skupine. Bila je predsednica uglednih mednarodnih znanstvenih združenj ter – kljub pregovoru, da nihče ni prerok v svoji domovini (še posebej ne ženska) – predsedovala tudi Inženirski akademiji Slovenije. Bila je zelo zaželena predavateljica na mednarodnih konferencah in odličnih univerzah po vsem svetu, res prava ambasadorka znanosti. Prispevala je k vzgoji stotin inženirjev in desetin doktorjev znanosti, ki s svojimi dosežki pobirajo medalje v številnih znanstvenih združenjih in državah. Tudi na MPŠ je postavila zglede doktorskega študija v doseganju visoke znanstvene kakovosti in uspešnega prenosa dosežkov v tiste procese, za katere danes upamo, da bodo uveljavili Evropo – in pri tem mislimo seveda tudi, če ne predvsem, na Slovenijo – kot nosilko visokih tehnologij za ustvarjanje tolikšne dodane vrednosti, da se ne bomo le izvlekli iz krize, temveč ohranili ali morda kar dvignili svojo življenjsko raven.

Po drugi strani pa je imela in razdajala toliko topline in vedrine, da je bila za vse okoli nje "naša Marička". Pa ne, da bi bila kdajkoli mlačna voda. Celo ne studenec. Bolj je bila podobna hudourniku, ki – ko si izbere svojo strugo – drvi vsemu novemu naproti. Nekateri pravijo, da je bila borka. Kaj pa ji je drugega v tej naši ozki dolini šentflorjanski preostalo? Res se ob udarcih na svoji poti ni zatekla na bližnji kamen in tožila, raje je udarila nazaj. Včasih tudi malo za preventivo. Svoje sodelavce je nemalokrat podila. Vendar je vselej, res prav vselej, prepoznala ustvarjalnost in jo z navdušenjem podprla. Svojo visoko inteligenco in garaške navade je obogatila še z vedrino in humorjem. Marsikdaj bi se huje sprli, če nam ne bi znala tako jasno predočiti, kako smešne so te naše drobne zamere.

Pot naprej? Vrhunska kakovost raziskovanja in izobraževanja, merjenje z mednarodnim metrom, razdajanje znanja, široka odprtost za ideje in ljudi, odločenost za pot navzgor in zavest da je čas zlato, ki ga ne kaže zapravljati. A tudi širina v sprejemanju drugačnega, toplina v odnosih, premoščanje napetosti, ljubezen do življenja. Skratka: model Marička.

LOOKING BACK – WHO CAN LEAD THE WAY?

Professor Marija Kosec (1947 – 2012)

IPS Vice-Presidant

The name of Marija Kosec, IPS Professor for the Nanosciences and Nanotechnologies programme, is carved into the history of our School, which she helped to establish with her defiance and infectious joy.

As a matter of fact, we could say that she had a double personality. On the one hand, she was a very serious, eminent researcher who knew how to think and work hard. She published her achievements in the field of electronic ceramics in hundreds of articles with thousands of citations. She managed tens of demanding international projects, as well as organising and managing numerous successful research groups. She was president of esteemed international scientific organisations and – despite the saying that no one is a prophet in his homeland (especially not a woman) – President of the Slovenian Academy of Engineering. She was a very sought-after lecturer at international conferences and leading universities all around the world, a true ambassador of science. She contributed to the education of hundreds of engineers and tens of doctors of science, whose achievements are winning awards from numerous scientific organisations and from different countries. At the IPS she also developed a role model of doctoral studies in reaching high scientific quality and a successful transfer of the achievements to those processes that will hopefully make Europe – and by Europe we also, if not especially, mean Slovenia – the leading force of high technologies for creating the added value that will not only take us out of the crisis, but also preserve or even improve the quality of our lives.

Prof. Kosec carried within her and spread around so much warmth and optimism that everyone around her called her "our Marička". Not that she could ever be described as warm water. Not even a spring. She was more like a torrent, which – when it selects its path – rushes towards everything that is new. Some say she was a fighter. What else was left for her here in this "Šentflorjanska" valley with narrow horizon? It is true she did not cry or complain when obstacles appeared in her path. She rather fought back. Sometimes even in advance, for prevention. She often expected a lot from her co-workers. However, she always, truly at all times, recognised creativity and supported it enthusiastically. She added optimism and humour to her high intelligence and hardworking habits. We would often end up in serious disputes, if it were not for her clear way of presenting just how ridiculous our tiny resentments are.

Moving forward? Top quality in research and education, measured by international standards, spreading knowledge, great openness to ideas and people, determination to move forward and awareness that time is too precious to waste. But also broad-mindedness in accepting differences, establishing warm relations, surpassing tension and loving life. In short: the Marička model.

Študijski program INFORMACIJSKE IN KOMUNIKACIJSKE TEHNOLOGIJE

Prof. dr. Franc Novak

Predstojnik študijskega programa Informacijske in komunikacijske tehnologije

Head of the Information and Communication Technologies Programme

Študijski program ***Informacijske in komunikacijske tehnologije*** je interdisciplinarni podiplomski program, ki sledi najnovejšim težnjam področja, z odličnimi raziskovalnimi rezultati pa tudi neposredno prispeva k preseganju obstoječih meja znanja in tehnologij na svojem področju. Študijski program zajema naslednja področja: tehnologije znanja, napredne internetne tehnologije, računalniške strukture in sistemi, inteligentni sistemi in robotika, sodobni koncepti v telekomunikacijah.

Študijski program je usmerjen v reševanje realnih problemov in izzivov sodobne družbe. Primera takih izzivov sta internet prihodnosti in ambientalna inteligenca kot dejavnika, ki bosta v prihodnjih letih odločilno vplivala na življenje družbe. Kljub pomislekom, da posegata v življenjski prostor posameznika, ju velja sprejeti kot izziv za nadaljnji razvoj in priložnost za uresničevanje ustvarjalnih idej. Tudi ponavljajoče ekonomske krize bodo v bodoče krojile usodo delovnih mest v številnih gospodarskih panogah. Že za samo preživetje je ključnega pomena osnovno poznavanje informacijskih in komunikacijskih tehnologij, poglobljeno znanje s tega področja pa postaja nepogrešljivo pri raziskovalnem delu, razvoju novih izdelkov in storitev, ekonomskih analizah, v medicini, v celotnem trajnostnem razvoju.

Study Programme INFORMATION AND COMMUNICATION TECHNOLOGIES

The ***Information and Communication Technologies*** *programme is an interdisciplinary, postgraduate programme following the newest trends in the field and directly contributing to crossing the existing limits in knowledge and technologies. The study programme incorporates the following fields: knowledge technologies, advanced internet technologies, computer structures and systems, intelligent systems and robotics, and advanced concepts in telecommunications.*

The study programme is oriented towards solving the real-life problems and challenges of modern society. The internet of the future and ambient intelligence are examples of such challenges and will be factors that considerably influence society in the future. Despite concerns that they interfere with the living space of an individual, it is worth accepting them as a challenge for future development and an opportunity for realising creative ideas. Recurrent economic crises will also design the future of workplaces in industry. A basic knowledge of information and communication technologies is of key importance for survival, while extensive knowledge of this field of science is becoming indispensable in research work, the development of new products and services, economic analyses, in medicine and in sustainable development in general.

Predstavitev, razprava, izmenjava idej

Presentation, discussion, exchange of ideas

UMEŠČENOST PROGRAMA V POTREBE UPORABNIKOV

Sodobne informacijske in komunikacijske tehnologije so bistvene za ekonomski in socialni napredek: učinkoviti novi načini izmenjave informacij širijo razvojne možnosti proizvodnje, storitvenega sektorja, znanstvenih, kulturnih in socialnih ustanov ter bistveno podpirajo prenos znanja v cilju trajnostnega razvoja družbe znanja. V vse bolj globaliziranem gospodarstvu so informacijske in komunikacijske tehnologije ključne za kompetitivnost in gospodarsko rast – tako podjetij kot celotnih držav. Razvoj družbe znanja je primarno odvisen od razvoja na znanju temelječega gospodarstva, le-to pa od najvišje izobraženih in podjetnih strokovnjakov, ki obvladajo hiter dostop do informacij, učinkovite načine njihovega urejanja in prepoznavanja bistvenih sporočil ter njihovega vključevanja v reševanje problemov pri razvoju in optimizaciji novih postopkov, proizvodov in storitev. Informacijske in komunikacijske tehnologije imajo posebno vlogo pri višanju zaposlitvene strukture na vsakem področju, saj Evropa – in v njej Slovenija – lahko zdrži svetovno konkurenco samo z visoko usposobljenostjo zaposlenih, v kateri je sposobnost pridobivanja, urejanja, prenosa in uporabe informacij neogibna zahteva.

Podiplomski študijski program ***Informacijske in komunikacijske tehnologije*** zato nudi bodočim magistrom in doktorjem znanosti temeljna znanja na naštetih področjih, obenem pa jih pripravlja na reševanje ključnih razvojnih problemov, kot so večanje učinkovitosti procesov v proizvodnji in trženju, podpora menedžmentu v podjetjih in upravnih organih, razvoj novih gospodarskih panog, varovanje okolja in zdravja ter v vseh odpiranje novih možnosti kakovostnega zaposlovanja.

Pridobivanje učnih podatkov za ocenjevanje človekove porabe energije
Acquisition of training data for human energy expenditure estimation

PROGRAMME IN RELATION TO USER NEEDS

Advanced information and communication technologies are of crucial importance for economic and social advancement: efficient new ways of information exchange create new development possibilities for production, services, scientific, cultural and social institutions, and essentially support the transfer of knowledge, aiming for sustainable development of the knowledge society. In an increasingly globalised economy, information and communication technologies are crucial for the competitiveness and economic growth of companies, as well as countries. The development of a knowledge society primarily depends on the development of a knowledge-based economy, while the economy depends on highly educated and ambitious experts who master fast access to information, efficient ways of organising the data and recognising essential messages as well as their application to problem-solving in the development and optimisation of new procedures, products and services. Information and communication technologies play an important role in improving the employment structure in all fields, as Europe – and consequently Slovenia – can only compete on a world-wide basis with highly qualified staff that have the ability to acquire, manage, transfer and implement information.

The ***Information and communication technologies*** *postgraduate study programme therefore offers future masters and doctors of science basic knowledge in the above-mentioned fields, and at the same time prepares them for solving key development problems, for example, increasing the efficiency of processes in production and marketing, supporting the management in companies and administrative bodies, developing new industries, protecting the environment and health, as well as creating new possibilities for high-quality employment.*

Na Študentski konferenci
At the Students' Conference

CILJI ŠTUDIJSKEGA PROGRAMA

Glavni cilj študijskega programa ***Informacijske in komunikacijske tehnologije*** je pridobivanje vrhunskih znanj in razvijanje sposobnosti njihove uporabe za izboljšanje učinkovitosti procesov dela in odločanja, s posebnim poudarkom na razvijanju in prenosu visokih računalniških in telekomunikacijskih tehnologij. Uporaba pridobljenih znanj vključuje obvladovanje omrežij in visoko zmogljivih računalniških virov za računalniško podprto upravljanje in prenos znanj ter analizo obsežnih podatkovnih baz/skladišč, ki nastajajo kot rezultat znanstvenih raziskav na področjih fizike, kemije, biologije, biokemije in farmakologije, bioinformatike, okoljskih znanosti ter delno tudi na področjih družboslovnih in ekonomskih ved, kot tudi podatkov, ki se kopičijo kot posledica ambientalnih meritev in zajemanja podatkov na svetovnem spletu.

IZVAJANJE ŠTUDIJSKEGA PROGRAMA

Študijski program ***Informacijske in komunikacijske tehnologije*** se prek mentorjev vključuje v raziskovalne in razvojne projekte, v katere umešča svoje podiplomske študente. Prednost zagotavlja domačim in mednarodnim projektom za razvoj temeljnih znanj in podporo v proizvodnji, storitvenih dejavnostih in javnih službah. Program poudarja ekonomsko učinkovitost v skladu z načeli trajnostnega razvoja. Raziskave v sklopu programa potekajo zlasti na področjih:

- tehnologije znanja,
- napredne internetne tehnologije,
- računalniške strukture in sistemi,
- inteligentni sistemi in robotika,
- sodobni koncepti v telekomunikacijah.

Laboratorijske meritve

Measurements in a laboratory

OBJECTIVES OF THE STUDY PROGRAMME

The principle objective of the ***Information and Communication Technologies*** *programme is to acquire superior knowledge and develop the ability to use it in order to improve the efficiency of work processes and decision-making, with a special emphasis on the development and transfer of computer and telecommunications technologies. The implementation of the acquired knowledge incorporates the mastering of networks and high-capacity computer resources for computer-aided management and knowledge transfer, and the analysis of extensive databases and data warehouses, resulting from scientific research in the area of physics, chemistry, biology, biochemistry and pharmacology, bioinformatics, environmental science, and partially social sciences and economics, as well as the data that is being clustered as a consequence of ambient measurements and data acquisition on the world wide web.*

IMPLEMENTATION OF THE STUDY PROGRAMME

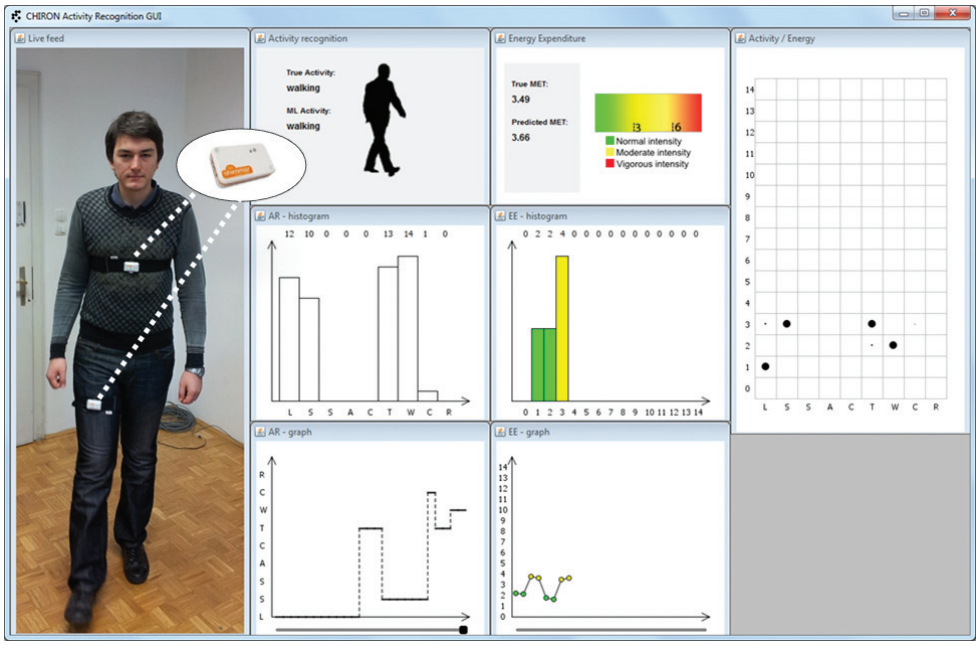
The Information and Communication Technologies supervisors incorporate the programme into research and development projects where they also include their students. The programme gives priority to national and international projects for the development of the basic knowledge and support in production, the service industries and public services. The programme emphasises economic efficiency in accordance with the principles of sustainable development. The research in the framework of the programme focuses on the following fields:

- *knowledge technologies,*
- *advanced internet technologies,*
- *computer structures and systems,*
- *intelligent systems and robotics,*
- *advanced concepts in telecommunications.*

PRIMERI DOSEŽKOV

- **Prepoznavanje aktivnosti in zaznavanje padcev**

Hristijan Gjoreski (mentor prof. dr. Matjaž Gams) je v svojem magistrskem delu **Prilagodljivo prepoznavanje aktivnosti in zaznavanje padcev s senzorji na telesu** razvil metode za prepoznavanje aktivnosti in zaznavanje padcev z inercialnimi in lokacijskimi senzorji na telesu. Raziskave nadaljuje v okviru doktorskega študija na področju analize človeškega obnašanja s senzorji s pomočjo, pri čemer je poudarek na uporabi konteksta za izboljšanje rezultatov analize. Bil je član ekipe IJS, ki je zmagala na mednarodnem tekmovanju v prepoznavanju aktivnosti EvAAL (Evaluating AAL Systems through Competitive Benchmarking). Rezultate je objavil v treh člankih. Primer: Kozina Simon, Gjoreski Hristijan, Gams Matjaž, Luštrek Mitja. Three-layer activity recognition combining domain knowledge and meta-classification. *Journal of medical and biological engineering*, 2013, 33, 4, 406-414.



Prepoznavanje aktivnosti in ocenjevanje porabe človekove energije

Activity recognition and human energy expenditure estimation

- **Razvoj modela radijskega kanala za posebna okolja**

Dr. Andrej Hrovat (mentor prof. dr. Gorazd Kandus) je v okviru disertacije z naslovom **Razširjanje radijskih valov v posebnih okoljih** na podlagi meritev jakosti signala v predorih različnih oblik in dimenzij v frekvenčnem pasu od 300 MHz do 3 GHz razvil nov izviren empiričen model razširjanja radijskega signala za izračun izgube poti v posebnih okoljih. Ovrednotenje merilnih rezultatov in modela je dodatno izvedel s pomočjo simulacijskega programa, v katerem je modeliral dejansko okolje, v katerem so potekale meritve. Raziskovalne dosežke v okviru disertacije, zlasti nov empirični model ter prispevke k modeliranju razširjanja radijskega signala v posebnih okoljih, je opisal v več člankih, objavljenih v mednarodnih revijah, in predstavil na strokovnih srečanjih. Primer: Hrovat Andrej, Kandus Gorazd, Javornik Tomaž. A survey of radio propagation modeling for tunnels. *IEEE Communications surveys and tutorials*, 2014, 16, 2, 658-669.

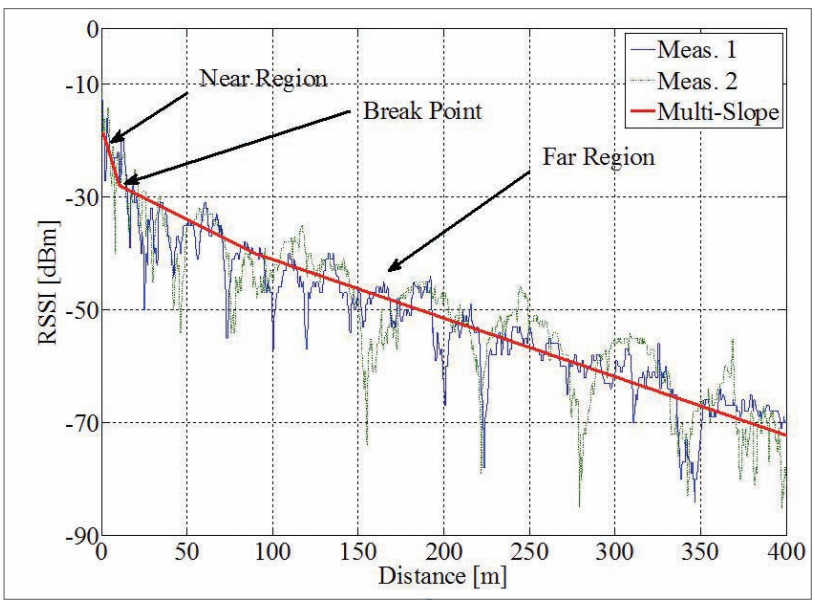
EXAMPLES OF ACHIEVEMENTS

- ***Activity recognition and fall detection***

Hristijan Gjoreski *(Supervisor Professor Matjaž Gams), in his master's thesis entitled* ***Adaptive human activity recognition and fall detection using wearable sensors*** *developed methods for activity recognition and fall detection with inertial and location sensors. He continues his research as a doctoral student, working on human behaviour analysis with sensors, with the emphasis on using the context to improve the results of the analysis. He was a member of the JSI team that won the international activity-recognition competition EvAAL (Evaluating AAL Systems through Competitive Benchmarking). His results were published in three journal papers. Example: Kozina Simon, Gjoreski Hristijan, Gam, Matjaž, Luštrek Mitja. Three-layer activity recognition combining domain knowledge and meta-classification. Journal of medical and biological engineering, 2013, 33, 4, 406-414.*

- ***Development of a radio-channel model for special environments***

Dr. Andrej Hrovat *(Supervisor Professor Gorazd Kandus) has in the content of his dissertation entitled* ***Radio wave propagation in special environments*** *proposed a new empirical radio-propagation model for path loss prediction in special environments that has been developed, based on radio-signal strength measurements in tunnels with different shapes and sizes in the frequency band between 300 MHz and 3 GHz. The measurement results and the proposed model were additionally verified using a simulation tool where the actual environments of the field measurements were modelled. The research results from the dissertation, especially the new empirical model and contributions to modelling radiowave propagation in special environments, have been described in several papers, published in international journals and presented at conferences. Example: Hrovat Andrej, Kandus Gorazd, Javornik Tomaž. A survey of radio propagation modeling for tunnels. IEEE Communications surveys and tutorials, 2014, 16, 2, 658-669.*

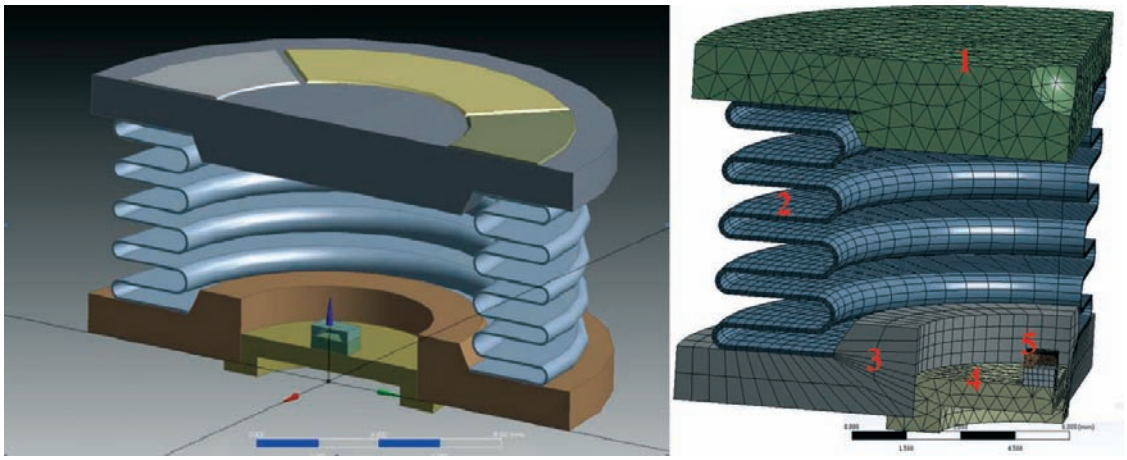


Merjenje radijskega signala v predoru

Radio signal measurements in a tunnel

- **Razvoj hidravlične merilne celice**

Dr. Roman Pačnik (mentor prof. dr. Franc Novak) je razvil hidravlično merilno celico za univerzalni kuhinjski aparat z integrirano funkcijo tehtanja, ki jo bo možno uporabiti v mreži senzorjev za spremljanje dinamičnih lastnosti in nadzor kuhinjskega aparata. Z inovativno zasnovo kovinskega meha, izdelanega v hidromorfing tehnologiji, in s skrbno izbranimi materiali je dosegel velik odziv izhodne napetosti v odvisnosti od vhodne obremenitve. To daje dobro razmerje signal/šum in zagotavlja visoko odpornost na elektromagnetne motnje v kuhinjskem aparatu, kar je prednost pred tradicionalnimi merilnimi celicami. Glavne karakteristike so bile izmerjene v skladu s priporočilom OIML R 60. Dobljeni rezultati izpolnjujejo postavljene osnovne zahteve za namene v ciljni aplikaciji. Rezultati so bili objavljeni v članku: Pačnik Roman, Novak Franc. A high-sensitivity hydraulic load cell for small kitchen appliances. *Sensors*, 2010, 10, 9, 8452-8465.



Presek modelirane hidravlične celice in njen model z metodo končnih elementov

A 3D cross-section view of the modelled hydraulic load cell and its finite element method model

- **Brezžični vmesnik za nadomeščanje kablov pri nadzoru bolnikov v intenzivni negi**

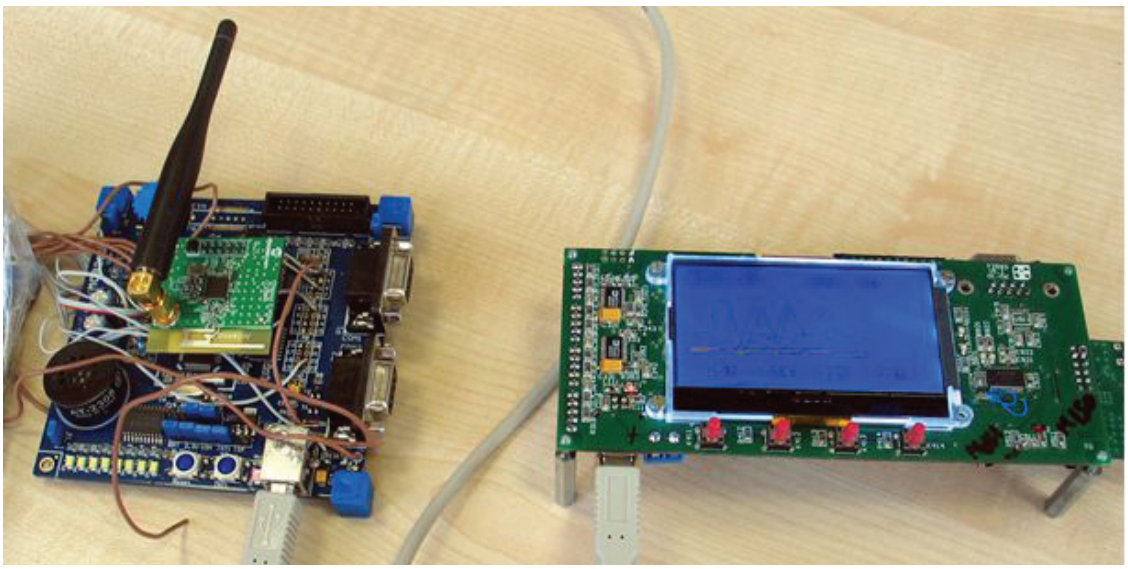
Mag. Marko Pavlin (mentor prof. dr. Franc Novak) je v svojem doktorskem delu **Brezžično procesiranje biomedicinskih signalov z nizko porabo** zasnoval brezžični vmesnik za nadomeščanje kablov pri nadzoru bolnikov v intenzivni negi. Razvita arhitektura omogoča sočasno spremljanje signalov brez dodatnih prilagoditev obstoječih merilnih inštrumentov. Dosežki so objavljeni v petih mednarodnih patentnih prijavah in dveh člankih. Primer: Pavlin Marko, Novak Franc. A wireless interface for replacing the cables in bridge-sensor applications. *Sensors*, 2012, 12, 8, 10014-10033.

- ***Development of a hydraulic load cell***

Dr. Roman Pačnik *(Supervisor Franc Novak) in his thesis with the title Hydraulic load cells for measurement of small loads developed a hydraulic load cell for a small kitchen appliance with a weighing function integrated into a control loop in order to prevent the unbalanced movement of the appliance during operation. With an innovative design of hydroformed metallic bellows and careful selection of materials, a high response of the output voltage to the applied load has been obtained. It ensures good noise immunity and ensures its advantage over conventional strain-gauge load cells. The main characteristics were measured in accordance with the OIML R 60 recommendation, and the obtained results fulfil the requirements imposed by the target application. The results were published in: Pačnik Roman, Novak Franc. A high-sensitivity hydraulic load cell for small kitchen appliances. Sensors, 2010, 10, 9, 8452-8465.*

- ***A wireless interface for replacing cables in patient monitoring for intensive care***

Marko Pavlin, MSc *(Supervisor Professor Franc Novak) in his doctoral dissertation entitled* ***Yield enhancement of piezoresistive pressure sensors for automotive applications*** *addressed problems related to low-power wireless biomedical signal processing. He designed a wireless interface for replacing the cables in patient monitoring for intensive care. The developed architecture enables the simultaneous multiple monitoring of signals with no additional modification to the existing measurement instruments. The results are subject to five international patent claims and two papers. Example: Pavlin Marko, Novak Franc. A wireless interface for replacing the cables in bridge-sensor applications. Sensors, 2012, 12, 8, 10014-10033.*



Prototip brezžičnega vmesnika

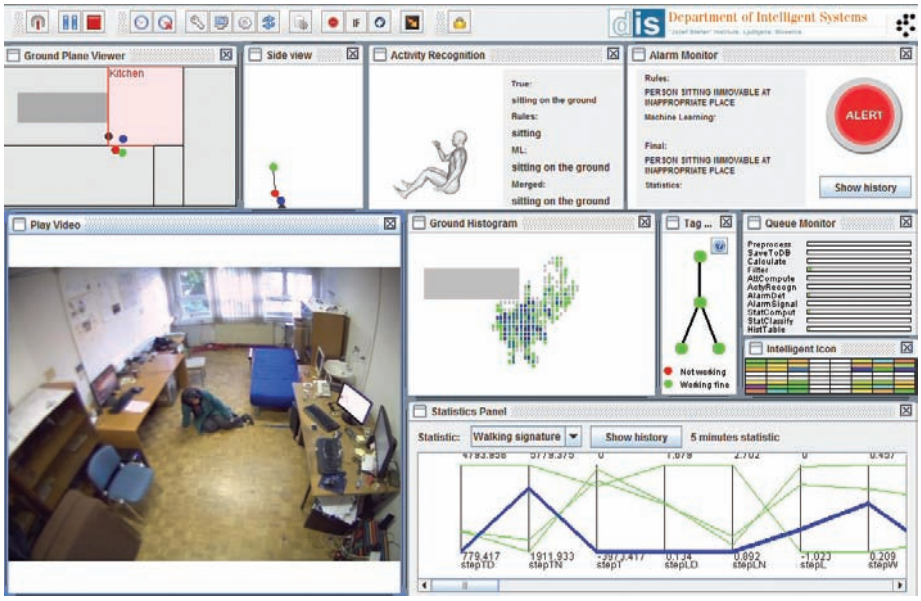
Wireless interface prototype

- **Metodologija SegMine za semantično analizo podatkov mikromrež**

Dr. Vid Podpečan (mentorica prof. dr. Nada Lavrač) je v okviru svoje disertacije **Odkrivanje zakonitosti iz podatkov v okolju spletnih servisov** razvil metodologijo SegMine, ki omogoča semantično analizo podatkov o izraženosti genov s povezavo algoritma za semantično odkrivanje podskupin s postopkom interaktivnega hierarhičnega razvrščanja v skupine ter s sistemom Biomine za verjetnostno odkrivanje povezav. SegMine omogoča razlago podatkov ter postavljanje znanstvenih hipotez z združevanjem eksperimentalnih podatkov in javno dostopnega znanja. Metodologija je implementirana v orodju Orange4WS kot množica interaktivnih komponent delotokov ter ovrednotena na dveh naborih podatkov: znanem naboru o kliničnem testiranju akutne limfoblastne levkemije (ALL) ter naboru podatkov o senescenci človeških zarodnih celic (MSC). Ekspertna analiza podatkov o zarodnih celicah z metodologijo SegMine je vodila v oblikovanje treh novih znanstvenih hipotez. Raziskovalne dosežke je objavil v sedmih člankih. Primer: Podpečan Vid, Lavrač Nada, Mozetič Igor, Kralj Novak Petra, Trajkovski Igor, Langohr Laura, Kuloves, Kimmo, Toivonen Hannu, Petek Marko, Motaln Helena, Gruden Kristina. SegMine workflows for semantic microarray data analysis in Orange4WS. *BMC Bioinformatics*, 2011, 12, 416, 1-16.

- **Prepoznavanje zdravstvenih težav, ki se kažejo v gibanju bolnika**

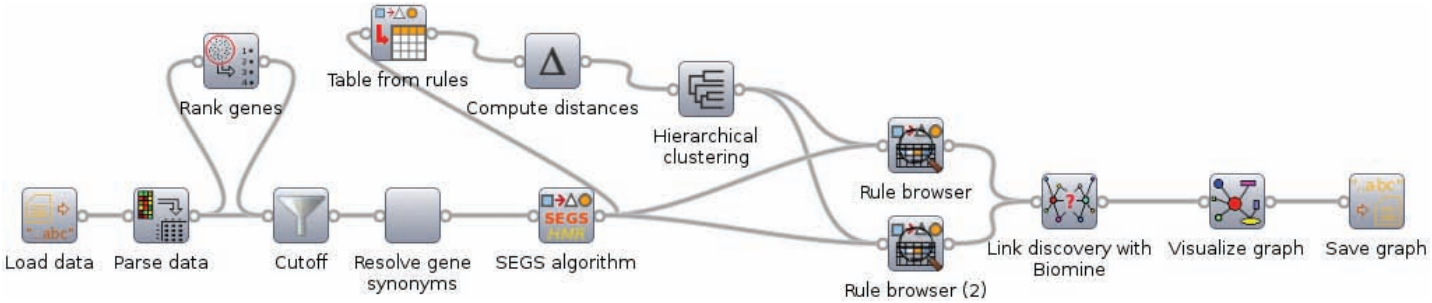
Dr. Bogdan Pogorelc (mentor: prof. dr. Matjaž Gams) je v okviru doktorske disertacije z naslovom **Zdravstveni nadzor starejših z odkrivanjem zakonitosti v podatkih iz sistemov za zajemanje gibanja** razvil nov pristop za prepoznavanje zdravstvenih težav, ki so pogoste pri starostnikih in se kažejo v gibanju bolnika (npr. Parkinsonova bolezen in hemiplegija). Bistveni novosti pristopa sta uporaba atributov za strojno učenje, ki semantično opišejo zdravstveno stanje, in uporaba metode dinamičnega časovnega prilagajanja (angl. dynamic time warping). V povezavi s svojim doktorskim delom je objavil sedem člankov. Primer: Pogorelc Bogdan, Gams Matjaž. Detecting gait-related health problems of the elderly using multidimensional dynamic time warping approach with semantic attributes. Multimedia tools and applications, 2013, 66, 1, 95-114.



Zaznavanje padcev in nenavadnega gibanja
Detection of falls and unusual movement

- ***SegMine methodology for a semantic micro-array data analysis***

Dr. Vid Podpečan *(Supervisor Professor Nada Lavrač) has in his dissertation* ***Knowledge discovery in a service-oriented data mining environment*** *developed the SegMine methodology, which enables a semantic analysis of gene expression data by integrating a semantic subgroup discovery system SEGS, interactive hierarchical clustering, and a probabilistic link discovery system called Biomine. SegMine enables advanced data interpretation and the formulation of new research hypotheses by integrating the analysis of experimental data with publicly available knowledge. The methodology was implemented in the Orange4WS platform as a set of interactive workflow components and evaluated on two data sets, a well-known dataset from a clinical trial in acute lymphoblastic leukaemia (ALL) and a dataset about senescence in human mesenchymal stem cells (MSCs). The experiments on the mesenchymal stem-cells data set resulted in the formulation of three new scientific hypotheses. His achievements were published in seven papers. Example:* Podpečan Vid, Lavrač Nada, Mozetič Igor, Kralj Novak Petra, Trajkovski Igor, Langohr Laura, Kulovesi Kimmo, Toivonen Hannu, Petek Marko, Motaln Helena, Gruden Kristina. *SegMine workflows for semantic microarray data analysis in Orange4WS. BMC Bioinformatics, 2011, 12, 416, 1-16.*



Delotok za analizo genov v platformi Orange4WS

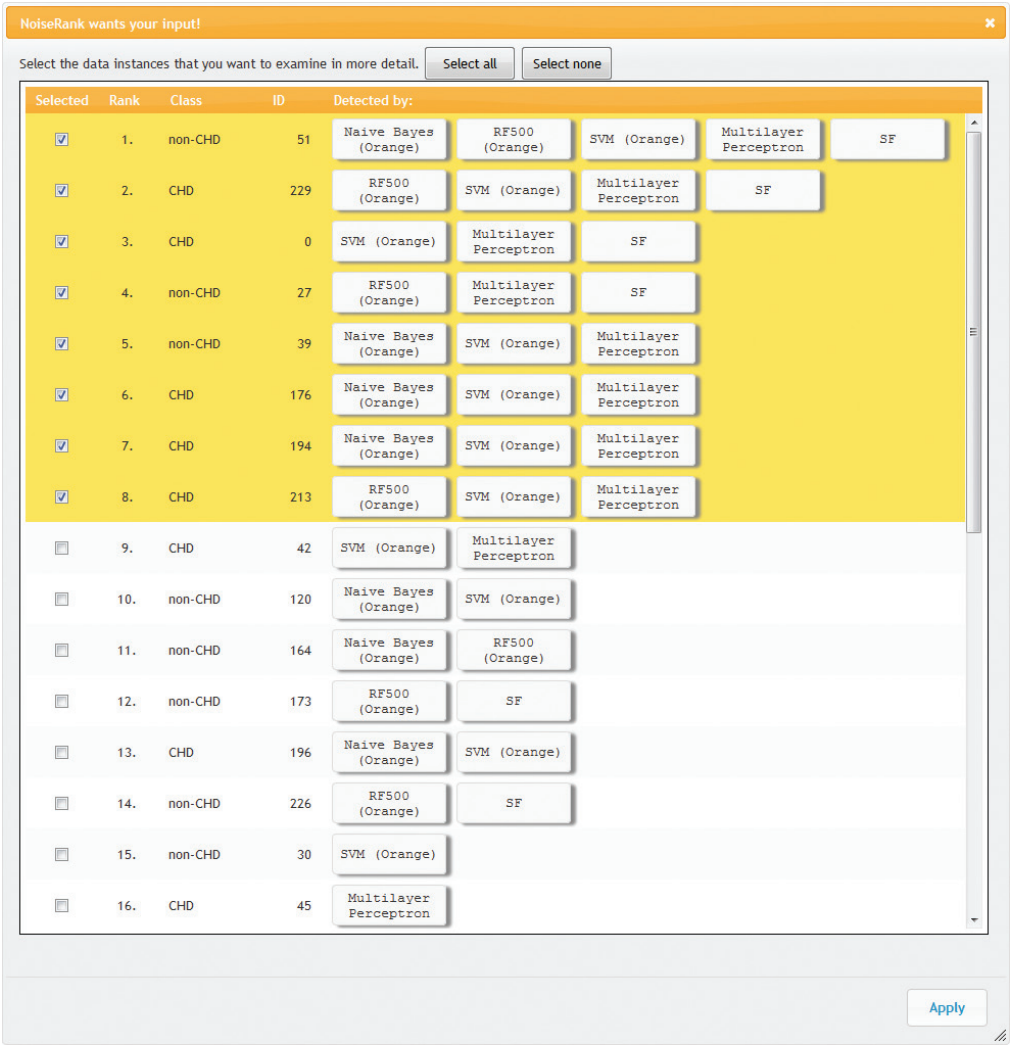
Workflow for the analysis of gene expressions in the Orange4WS platform

- ***Recognition of health problems manifesting in the patient's movement***

Dr. Bogdan Pogorelc *(Supervisor Professor Matjaž Gams) in his doctoral dissertation entitled* ***Data-mining based health monitoring of elderly using motion-capture data*** *developed a new approach to the recognition of health problems in the elderly that manifest in the patient's movement (e.g., Parkinson's disease and hemiplegia). The key contributions of his approach are the use of machine-learning attributes that semantically describe the health condition, and the use of dynamic time warping. His doctoral work resulted in the publication of seven papers. Example:* Pogorelc Bogdan, Gams Matjaž. *Detecting gait-related health problems of the elderly using multidimensional dynamic time warping approach with semantic attributes. Multimedia tools and applications, 2013, 66, 1, 95-114.*

- **Metoda NoiseRank za odkrivanje anomalij v podatkih**

Dr. Borut Sluban (mentorica prof. dr. Nada Lavrač) je v okviru svoje disertacije **Ansambelsko odkrivanje šuma in osamelcev v podatkih** implementiral ansambelsko metodo NoiseRank za odkrivanje in rangiranje šuma, napak in osamelcev v podatkih. To omogoča izbor algoritmov za odkrivanje šuma ter pregled odkritih šumnih primerov. Metoda je bila uspešno uporabljena v medicini za odkrivanje atipičnih ali napačno diagnosticiranih primerov, kot tudi v analizi tekstov za odkrivanje nenavadnih člankov in napak pri zajemanju korpusa. Uporaba metodologije NoiseRank je bila omogočena z njeno implementacijo v spletni platformi ClowdFlows. Razvito je bilo spletno okolje ViperCharts, ki omogoča vizualno vrednotenje in primerjavo kakovosti algoritmov za odkrivanje anomalij v podatkih, uporabno tudi za vrednotenje drugih algoritmov strojnega učenja in podatkovnega rudarjenja. Raziskovalne dosežke je objavil v treh člankih. Primer: Sluban Borut, Lavrač Nada, Gamberger Dragan. Ensemble-based noise detection: noise ranking and visual performance evaluation. *Data Mining and Knowledge Discovery*, 2014, 28, 2, 265-303.



Evalvacija metod za analizo šuma pri različnih tipih raka

Evaluation of noise analysis methods for different types of cancer

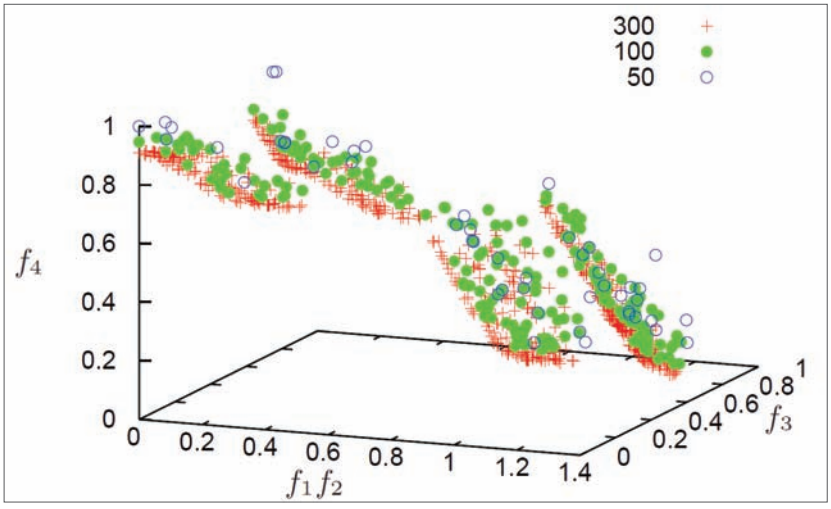
- ***NoiseRank method for anomaly detection in data***

Dr. Borut Sluban *(Supervisor Professor Nada Lavrač) developed an ensemble-based method called* ***NoiseRank for the detection and ranking of noise, errors and outliers in data****. The method makes it possible to use arbitrary noise-detection algorithms and offers to explore the detected noisy instances. NoiseRank was successfully applied in the medical domain for the detection of atypical and falsely diagnosed cases, as well as in the analysis of textual data for the detection of unusual articles and errors in the corpus-collection process. Public use of the NoiseRank method was enabled by its implementation in the web-based data-mining platform ClowdFlows. Additionally, the ViperCharts web environment was developed for the performance evaluation of noise and outlier-detection algorithms, as well as for the evaluation of other machine-learning and data-mining algorithms. The research results were published in three papers. Example: Sluban Borut, Lavrač Nada, Gamberger Dragan. Ensemble-based noise detection: noise ranking and visual performance evaluation. Data Mining and Knowledge Discovery, 2014, 28, 2, 265-303..*

Udeleženci 5. Študentske konference MPŠ med ogledom posterjev
Participants of the 5th IPS Students' Conference during poster session

- **Vizualizacija rešitev v večkriterijski optimizaciji**

Mag. Tea Tušar (mentor prof. dr. Bogdan Filipič) je v okviru svoje doktorske raziskave **Vizualizacija rešitev v večkriterijski optimizaciji** razvila in teoretično utemeljila izvirno metodo vizualizacije rešitev optimizacijskih problemov z več nasprotujočimi si kriteriji. Metoda zmanjša dimenzionalnost množice rešitev in jo pregledno prikaže v obliki t. i. prosekcijske matrike. To odločevalcu omogoča boljši vpogled v kakovost rešitev in lastnosti optimizacijskega problema. Metoda je zlasti uporabna v inženirskem načrtovanju, optimizaciji proizvodnih procesov in višanju energetske učinkovitosti. Objavljena je v štirih konferenčnih prispevkih in znanstveni reviji z najvišjim faktorjem vpliva na področju Computer Science, Theory and Methods: Tušar Tea, Filipič Bogdan. Visualization of Pareto front approximations in evolutionary multiobjective optimization: A critical review and the prosection method. *IEEE Transactions on Evolutionary Computation*, 2014 (v tisku).



Vizualizacija konvergence rešitev v večkriterijski optimizaciji

Visualisation of solution convergence in multiobjective optimisation

- **Modeliranje družbenih omrežij po vzoru stigmergije mravelj**

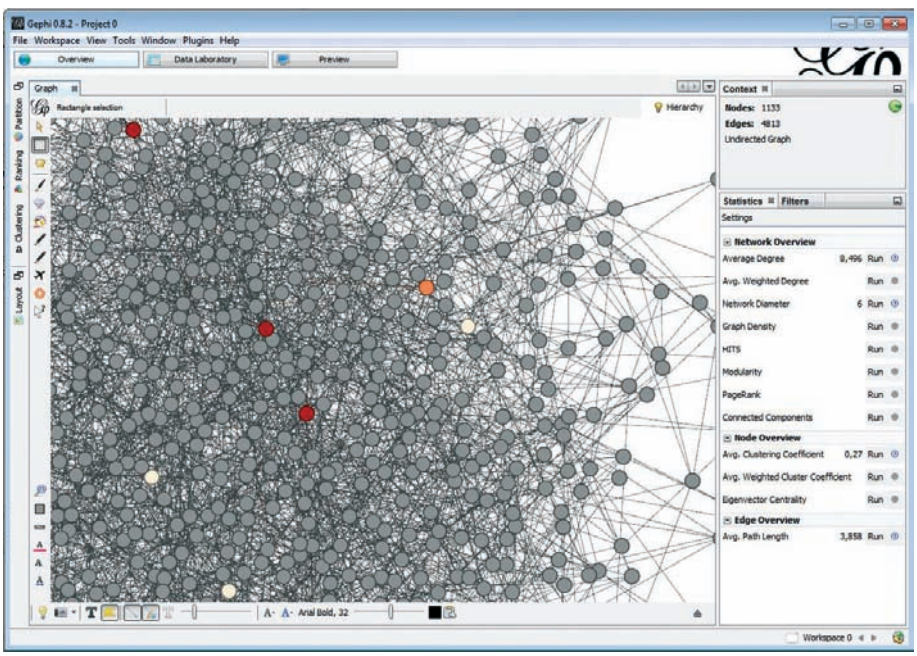
Pri študiji realnih kompleksnih omrežij nam mrežni modeli pomagajo razumeti interakcije, ki se dogajajo znotraj omrežij. V svoji doktorski disertaciji z naslovom **Veliki grafi v naprednih aplikacijah** je **dr. Vida Vukašinović** (mentor prof. dr. Jurij Šilc) predstavila nov model družbenega omrežja, ki je zasnovan na osnovi interakcij in temelji na teoriji uravnoteženosti ter izkorišča mehanizem posredne komunikacije – odlaganje in izhlapevanje feromona – značilen za socialno vedenje mravelj. Interakcije med posamezniki imajo podoben vpliv na interakcije v prihodnosti, kot jih imajo poti obogatene s feromonom na izbiro nadaljevanja poti pri mravlji. Za evalvacijo in validacijo modela je izračunala in analizirala različne značilnosti mrežnih modelov in realnega omrežja. V povezavi s svojim doktorskim delom je objavila štiri članke. Primer: Vukašinović Vida, Gregor Petr, Škrekovski Riste. On the mutually independent Hamiltonian cycles in faulty hypercubes. *Information sciences*, 2013, 236, 224-235.

- ***Visualization of solutions in multi-objective optimization***

In her doctoral research entitled ***Visualization of solutions in multi-objective optimization****,* ***Tea Tušar, MSc*** *(Supervisor Professor Bogdan Filipič) developed and theoretically analysed an original method for the visualization of solutions to optimization problems with multiple conflicting objectives. The method reduces the dimensionality of the solution set and clearly displays it in the form of the prosection matrix. This enables a decision maker to gain a better insight into the solution quality and problem properties. The method is especially well suited to engineering design, production process optimization and increasing energy efficiency. It was published in several conference papers and in the most prestigious journal in the category Computer Science, Theory and Methods: Tušar Tea, Filipič Bogdan. Visualization of Pareto front approximations in evolutionary multiobjective optimization: A critical review and the prosection method. IEEE Transactions on Evolutionary Computation, 2014 (in press).*

- ***Social-network modeling inspired by ant stigmergy***

Dr. Vida Vukašinović *(Supervisor Professor Jurij Šilc), in her dissertation* ***Large Graphs in Advanced Applications****, has studied complex social networks. In the study of real-world complex networks, network models can help us to understand the interactions within the network. In her dissertation, Vida Vukašinović introduced a new social network model, called the interaction-based model, which is based on balance theory in combination with pheromone deposition and evaporation found in the social behaviour of ants. In the interaction-based model, each interaction between two individuals influences future interactions in a similar way to how pheromone trails influence the ant's choice of its future path. She calculated and analysed the characteristics of different network models and real-world networks to evaluate and validate the model. The results of her doctoral dissertation are published in four papers. Example: Vukašinović Vida, Gregor Petr, Škrekovski Riste. On the mutually independent Hamiltonian cycles in faulty hypercubes. Information sciences, 2013, 236, 224-235.*



Model družabnega omrežja

Social network model

- **Večkriterijsko iskanje strategij vožnje**

Dr. Erik Dovgan (mentor prof. dr. Bogdan Filipič) je v svoji doktorski disertaciji z naslovom **Večkriterijsko iskanje strategij vožnje** razvil inovativen optimizacijski algoritem za iskanje optimalnih strategij vožnje glede na nasprotujoče si kriterije: potovalni čas, porabo goriva in udobnost vožnje. Z eksperimentalnim ovrednotenjem na podatkih o obstoječih cestah je pokazal izboljšave strategij vožnje v primerjavi z dosedanjimi metodami. Predlagani pristop bo uporaben v inteligentnih vozilih prihodnosti. Objavljen je v več konferenčnih prispevkih in v članku v znanstveni reviji: Dovgan Erik, Javorski Matija, Tušar Tea, Gams Matjaž, Filipič Bogdan. Discovering driving strategies with a multiobjective optimization algorithm. *Applied Soft Computing*, 2014, 16, 1, 50-62.

Uporabniški vmesnik sistema za večkriterijsko iskanje strategij vožnje

User interface of the system for multiobjective discovery of driving strategies

- **Zlati znak Jožefa Stefana**

Dr. Peter Korošec (mentor prof. dr. Bogdan Filipič, somentor doc. dr. Jurij Šilc) je prejel priznanje Zlati znak Jožefa Stefana za odmevno doktorsko delo leta 2008. V svoji disertaciji z naslovom **Stigmergija kot pristop k metahevristični optimizaciji** je obravnaval optimizacijo z metodami po zgledih iz narave. Njegov glavni prispevek je posplošitev metode za optimizacijo s kolonijami mravelj za uporabo na zveznih optimizacijskih problemih. Učinkovitost metode je eksperimentalno potrdil v načrtovanju elektromotorja z minimalnimi izgubami moči in optimizaciji procesnih parametrov v kontinuirnem ulivanju jekla.

- ***Multiobjective discovery of driving strategies***

In his doctoral dissertation entitled ***Multiobjective discovery of driving strategies****,* ***Dr. Erik Dovgan*** *(Supervisor Professor Bogdan Filipič) developed an innovative optimization algorithm for discovery of optimal driving strategies with respect to conflicting objectives of traveling time, fuel consumption and driving comfort. By an empirical evaluation on real route data he demonstrated the improvements of driving strategies in comparison to the existing methods. The approach was published in several conference papers and in the journal paper:* Dovgan Erik, Javorski Matija, Tušar Tea, Gams Matjaž, Filipič Bogdan. Discovering driving strategies with a multiobjective optimization algorithm. Applied Soft Computing, 2014, 16, 1, 50-62.

Prejemnik zlatega znaka Jožefa Stefana za odmevno doktorsko delo leta 2008 dr. Peter Korošec s somentorjem doc. dr. Jurijem Šilcem (levo) in mentorjem prof. dr. Bogdanom Filipičem (desno)

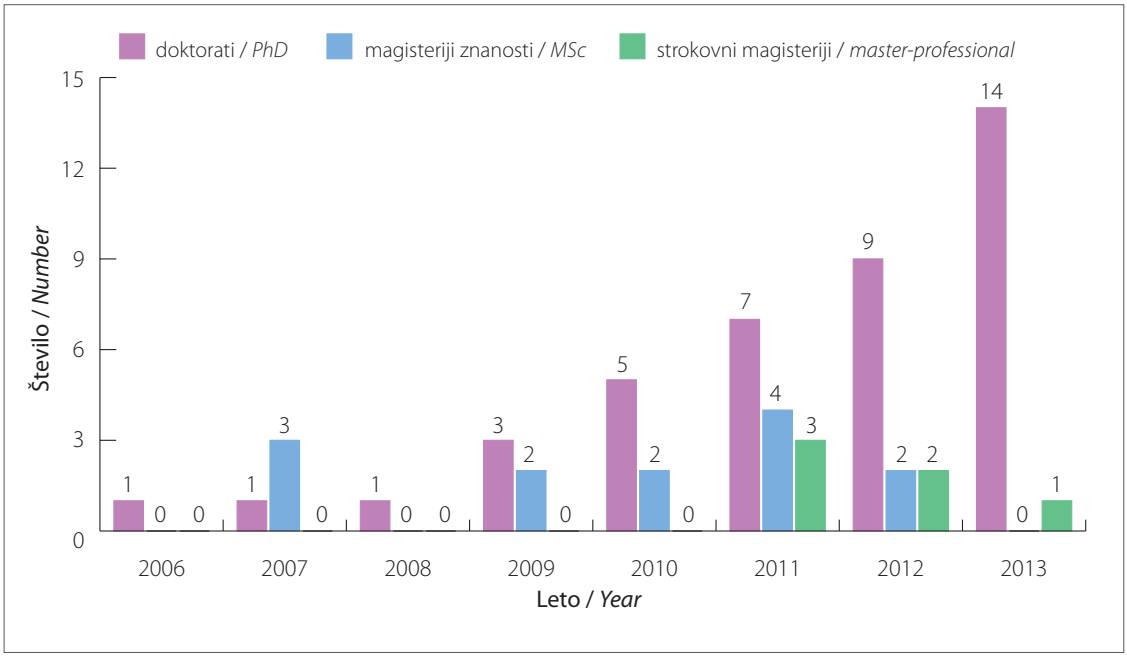
The recipient of the Jožef Stefan Golden Emblem award for an outstanding doctoral dissertation in 2008 Dr. Peter Korošec with his Co-Supervisor Assistant Professor Jurij Šilc (left) and Supervisor Professor Bogdan Filipič (right)

- ***Jožef Stefan Golden Emblem award***

Dr. Peter Korošec *(Supervisor Professor Bogdan Filipič, Co-Supervisor Assistant Professor Jurij Šilc) received a Jožef Stefan Golden Emblem award for an outstanding doctoral dissertation in 2008. In his dissertation entitled* ***Stigmergy as an approach to metaheuristic optimization*** *he dealt with bioinspired optimization methods. His key contribution is the generalization of the ant-colony optimization algorithm for application in continuous optimization problems. He experimentally demonstrated its effectivennes in the design of an electric motor with minimum power losses, and optimization of process parameters in continuous casting of steel.*

DOKTORJI IN MAGISTRI INFORMACIJSKE IN KOMUNIKACIJSKE TEHNOLOGIJE

V prvih 10 letih delovanja MPŠ je na programu ***Informacijske in komunikacijske tehnologije*** doktoriralo 41 in magistriralo 19 kandidatov. Od tega je študij končalo 30 kandidatov iz tujine. Večina del je bila vezana na reševanje realnih problemov analize podatkov, semantičnega spleta, novih medijev, industrijskih sistemov, robotike in telekomunikacij.



Doktorati in magisteriji na MPŠ v prvem desetletju, skupaj 60
PhD and MSc at IPS in the first decade, total 60

DOCTORS AND MASTERS OF INFORMATION AND COMMUNICATION TECHNOLOGIES

In the first ten years of the IPS, 41 doctors and 19 masters completed their studies as part of the ***Information and Communication Technologies*** *programme, of which 30 candidates came from abroad. Most of the theses discussed the possibilities of solving real-life problems in the fields of data analysis, semantic web, new media, industrial systems, robotics and telecommunications.*

Predstavitev raziskovalnih dosežkov na Študentski konferenci

Presentation of research results at the Students' Conference

KAJ PRAVIJO MAGISTRI IN DOKTORJI INFORMACIJSKIH IN KOMUNIKACIJSKIH TEHNOLOGIJ – ALUMNI MPŠ?

Dr. Lucas Benedičič
Raziskovalec v Službi za raziskave in razvoj
Telekom Slovenije, d.d.

Zahtevnost načrtovanja radijskih omrežij se je povečala z rastjo števila celic v sodobnih celičnih standardih. Zato je vloga računalnika kot pomožnega orodja za izvajanje hitrejših in natančnejših izračunov vse bolj pomembna. Tradicionalni pristopi za optimizacijo in načrtovanje sistemov v velikih sistemih odpovedo, zato se v sodobnih pristopih pri optimizaciji velikih sistemov uporabljajo vzporedne metode in metahevristični algoritmi.

Delovanje metahevurističnih algoritmov temelji na velikem številu poskusov in oceni kakovosti rešitev ter usmerjanju raziskovanja algoritma v iskalnem prostoru. Poskusi se izvajajo z modeliranjem radijskih omrežij in simulacijami, vendar imajo več pomanjkljivosti glede njihove fleksibilnosti in časa izvajanja simulacije. Velikost omrežij, ki jih je mogoče analizirati v sprejemljivem času, je običajno zelo omejena.

V svoji disertaciji sem zasnoval nove metode za načrtovanje in samodejno optimizacijo radijskih omrežij. Predstavil sem nove pristope za povečanje hitrosti simulacij pokrivanja radijskih omrežij in njihovo uporabo pri reševanju konkretnih optimizacijskih problemov v radijskih omrežjih.

Pri raziskovalnem delu so mi bili v veliko oporo sodelavci Odseka za računalniške sisteme Instituta »Jožef Stefan« in moj mentor prof. dr. Peter Korošec ter somentor doc. dr. Tomaž Javornik.

Študij na Mednarodni podiplomski šoli Jožefa Stefana mi je omogočil tudi vpogled v druga raziskovalna področja, vzpostavil sem lahko številne stike z raziskovalci doma in v tujini, kar mi koristi pri nadaljnjem razvojno-raziskovalnem delu.

WHAT MASTERS AND DOCTORS OF INFORMATION AND COMMUNICATION TECHNOLOGIES HAVE TO SAY – IPS ALUMNI?

Dr. Lucas Benedičič
Researcher at the Research and Development Department
Telekom Slovenije, d.d.

The complexity of the design of next-generation radio networks has grown with the adoption of modern standards. Therefore, the role of the computer for the faster delivery of accurate results has become increasingly important. Traditional approaches for the optimisation and design of systems fail when it comes to large systems, hence in modern approaches to the optimisation of larger systems, parallelisation methods and metaheuristic algorithms are used.

Metaheuristic algorithms are based on a large number of experiments, evaluations of the solution quality and the exploration of the search space. The experiments are carried out by modelling radio networks and simulations, but have major weaknesses with respect to the simulation time and the flexibility provided. The size of the networks that can be analysed in a reasonable time is typically very limited.

In my doctoral dissertation I developed novel methods for the planning and automatic optimisation of radio networks. I presented new approaches to increasing the speed of simulations of radio network coverage and their use in solving actual optimisation problems in radio networks.

Colleagues at the Computer Systems Department of the Jožef Stefan Institute, my Supervisor Professor Peter Korošec and Co-Supervisor Assistant Professor Tomaž Javornik provided me with great support during my research work.

Studying at the Jožef Stefan International Postgraduate School also offered me an insight into other research fields and I was able to establish numerous connections with researchers from Slovenia and abroad, which helps me in my further research and development.

Dr. Dragana Miljković
Podoktorska raziskovalka
Institut »Jožef Stefan«

Interdisciplinarne raziskave nudijo veliko izzivov, saj je v raziskovalnem delu potrebno preseči meje posameznih znanstvenih področij, a brez interdisciplinarnega dela bi veliko teoretičnih raziskav ostalo brez praktične uporabe. Sistemska biologija je interdisciplinarno področje znanosti, ki proučuje celične mehanizme na sistemskem nivoju z razvojem računalniških orodij, ki omogočajo analizo, vizualizacijo in simulacijo njihove dinamike. Računalniški pristopi so bistvenega pomena za reševanje temeljnih izzivov znanosti o življenju. Med odprtimi vprašanji v rastlinski biologiji so tudi: Kako napovedati, kdaj se bo rastlini uspelo obraniti pred napadom virusa in preživeti? Ali so določeni geni ali protein posebej pomembni za preživetje dane rastline?

Poskusila sem sestaviti doslej nepovezane gradnike bioloških sistemov, tj. gene, proteine in metabolite, v kompleksno biološko sestavljenko ter poiskati odgovore na zgoraj zastavljena vprašanja. Moje raziskave so bile na presečišču računalništva in biologije, tako da sem pridobila veliko znanj z obeh področij znanosti. Uporabila sem pristope procesiranja naravnega jezika za avtomatsko luščenje relacij in avtomatsko izgradnjo strukturnega modela biološkega omrežja ter uporabila optimizacijske metode za analizo dinamičnega obnašanja modeliranega biološkega omrežja. Uspela sem formalizirati in vključiti znanje ekspertov s področja biologije v računalniška orodja, ki sem jih uporabljala v svojih raziskavah, saj so ta orodja fleksibilna in jih je možno uspešno prilagoditi za potrebe gradnje bioloških modelov.

Hvaležna sem profesorjem programa Informacijske in komunikacijske tehnologije Mednarodne podiplomske šole Jožefa Stefana za pomoč in podporo v času doktorskega študija ter sodelavcem Nacionalnega inštituta za biologijo, ki so omogočili, da je moje delo praktično uporabno v bioloških raziskavah.

Dr. Dragana Miljković
Postdoctoral researcher
Jožef Stefan Institute

Interdisciplinary research poses many challenges because it brings different disciplines together. However, without an interdisciplinary approach, many results of theoretical studies would never find their way into practice. Systems biology is an interdisciplinary scientific field that investigates cellular mechanisms at the system level by developing computer tools to analyse, visualize and simulate their dynamic behaviour. This made computer science valuable and essential for solving vital problems in the life sciences. Some of the questions to which plant biology still searches for answers are: How can we predict when a certain plant will manage to defend itself from a pathogen attack and survive? Are there some particular genes or proteins of crucial importance that will eventually prevent a plant from dying?

I was trying to put together smaller pieces, like genes, proteins and metabolites, into a complex biological puzzle and find the answers to these questions. I worked at the intersection of computer science and biology and gained valuable knowledge about both of them. I used natural-language approaches to automatically obtain the structure of biological networks, and used mathematical optimization approaches to analyse the network's dynamic behaviour. I managed to formalize and incorporate the knowledge of biological experts in the software tools on which I worked during my PhD. These tools are flexible and adaptable and can be used for the construction of other biological models as well.

I am extremely grateful to the professors from the IPS Information and Communication Technologies programme for being so supportive and helpful during my doctoral studies, and also to my collaborators from the National Institute for Biology (NIB), who made my work meaningful and useful in practice.

Doc. dr. Peter Mrak
Univerza v Mariboru, Fakulteta za energetiko

Čedalje več sodobnih hišnih aparatov ima vgrajena kompleksna elektronska vezja, ki omogočajo, da je njihova uporaba prilagojena specifičnim zahtevam uporabnika, in krmilijo njihovo delovanje tako, da je energijska poraba čim manjša. Naprednejši aparati se povezujejo na internet, shranjujejo zgodovino svojega delovanja in se s pomočjo naprednih algoritmov samodejno prilagajajo človekovim potrebam.
Vgrajena kompleksna elektronika prinaša s seboj tudi kompleksen izziv: problem testiranja – tako v proizvodnji, kot tudi kasneje na terenu. Tega se v Gorenju, od koder sem prišel kot mladi raziskovalec iz industrije, zelo dobro zavedajo.

Moj doktorski študij na Mednarodni podiplomski šoli Jožefa Stefana je bil usmerjen v problematiko snovanja vgrajenega samodejnega testa sistema-v-čipu, pri čemer sem se osredotočil na testiranje analogno-digitalnih pretvornikov, ki so nepogrešljivi del vmesnika poljubnega elektronskega sistema z zunanjim svetom. Tako sem histogramsko metodo, ki se običajno izvaja s tradicionalnimi merilnimi instrumenti, realiziral v samem integriranem vezju. Vgrajeni samodejni test sistema-v-čipu sem zasnoval skladno s standardom IEEE 1500, kar je bila ena prvih tovrstnih rešitev, objavljenih v strokovni literaturi.

Ob študiju sem se seznanil s sodobnimi načrtovalskimi orodji, pridobljene izkušnje so se izkazale kot zelo koristne tudi pri moji nadaljnji profesionalni karieri. Vzpostavljeni stiki s kolegi na Institutu »Jožef Stefan« so obrodili prve sadove pri razvoju programskega orodja za simulacijo in optimizacijo delovanja hladilnega aparata za Gorenje d.d. Uspešno sem deloval kot vodja razvoja v podjetju Tesnila GK d.o.o., kjer smo razvili več namenskih strojev za avtomatski pregled izdelkov, tudi v sodelovanju z Institutom »Jožef Stefan«. Sem soustanovitelj podjetja Diff Avtomatizacija d.o.o., ki ponuja kompleksne rešitve s področja avtomatizacije s poudarkom na sistemih strojnega vida. Uspešno sodelovanje se nadaljuje tudi v okviru moje nove zaposlitve na Fakulteti za energetiko Univerze v Mariboru. Zanj si bom še naprej prizadeval, saj je sodelovanje v ustvarjanju in prenosu znanja ključ do uspeha tako doma kot v svetu.

Assistant Professor Peter Mrak
University of Maribor, Faculty of Energy Technology

More and more modern home appliances come with integrated, complex electronic circuits that enable adaptation to specific user needs and the minimisation of energy consumption. Advanced appliances can connect to the internet, save the history of their operation and automatically adjust to user needs by using advanced algorithms. Built-in complex electronics also entail a complex challenge: the problem of testing – in production as well as subsequently in the field. This is a challenge that Gorenje, where I came from as a young researcher from the industry, is well aware of.

My doctoral studies at the Jožef Stefan International Postgraduate School were oriented towards the issue of designing a built-in automatic test of a system-on-a-chip, where I focused on testing ADC cores, which are an indispensable part of the interface between the optional electronic system and the outer world. I implemented the histogram method, which is usually carried out with traditional measuring instruments, in the integrated circuit. I designed the built-in automatic test of the system-on-a-chip according to the IEEE 1500 standard, which was one of the first solutions of its kind to be published in the scientific literature.

During my studies I became acquainted with design tools and the experience I gained turned out to be very useful in my further professional career. The contacts I established with colleagues from the Jožef Stefan Institute already produced the first results in developing software for the simulation and optimisation of a Gorenje d.d. refrigeration appliance. I successfully held the position of the Head of Development at Tesnila GK d.o.o., where we developed several machines for the automatic inspection of products, also in cooperation with the Jožef Stefan Institute. I am the cofounder of Diff Avtomatizacija d.o.o., a company that offers complex solutions from the field of automation with the emphasis on machine vision. We also continue our successful collaboration in the framework of my new employment at the Faculty of Energy Technology, University of Maribor. I will continue to strive for good collaborations, as this is the key to national and international success in creating and transferring knowledge.

Dr. Roman Pačnik
Projektant – razvoj elektronike
BSH Hišni aparati d.o.o. Nazarje

V svoji doktorski disertaciji sem si zadal za cilj razviti majhne, ustrezno konstruirane hidravlične merilne celice, ki bodo dovolj robustne, zadovoljivo točne, z majhno napako nelinearnosti, temperaturno in časovno stabilne in kot take primerne za vgradnjo in uporabo v aparatih za namene tehtanja v merilnem območju do 5 kg. Doseganje navedenega cilja je pomembno s tržno-razvojnega vidika za proizvajalca BSH Hišni aparati, d. o. o., kjer sem zaposlen. Omeniti velja, da hidravlične merilne celice za merjenje mase z merilnim območjem do 50 kg v literaturi niso znane, kot tudi ne konstrukcijski principi za manjše in poenostavljene (cenejše) izvedbe, tako da je zastavljeni cilj predstavljal izziv tako z znanstvenega kot s tehnološkega vidika.

S pridobljenim poglobljenim znanjem ob študiju sorodnih tehnoloških rešitev, analize izbranih komponent in materialov in ob pomoči sodelavcev Instituta Instituta »Jožef Stefan« sem zasnoval model hidravlične celice in na osnovi simulacij z metodo končnih elementov zasnoval prototip merilne celice. Da bi lahko uspešno karakteriziral razvito merilno celico, sem zgradil avtomatizirano merilno mesto in z uporabo programske opreme LabVIEW uspešno izvedel zahtevane meritve. Te so na seriji prototipnih merilnih celic potrdile odlične karakteristike, vključno z majhno napako nelinearnosti, majhno napako histereze in velikim izhodnim razponom.

Ob študiju na Mednarodni podiplomski šoli Jožefa Stefana sem imel priložnost slediti najnovejšim dosežkom moje ožje raziskovalne usmeritve kot tudi širiti svoje znanje na druga zanimiva raziskovalna področja.

Dr. Roman Pačnik
Design Engineer – Electronics Development
BSH Hišni aparati d.o.o. Nazarje

The aim of my doctoral dissertation was to develop small, adequately constructed, hydraulic load cells, robust and stable enough, with a small nonlinearity error, thermal and temporal stability and as such appropriate for integration and use in appliances with a weighing function in the range up to 5 kg. Achieving the set goal is important from the market and development point of view for BSH Hišni aparati, d.o.o., the company where I work. It should be noted that hydraulic load cells for measuring masses of up to 50 kg are not known in the literature, nor are the construction principles for smaller and less advanced (and so less expensive) models, hence the set goal was challenging not only from a scientific but also from a technological standpoint.

With the acquired in-depth knowledge by studying related technological solutions, analysing the selected components and materials and with the help of colleagues from the Jožef Stefan Institute I developed a hydraulic load-cell model and designed the prototype of a load cell on the basis of simulations with the finite-element method. In order to be able to successfully characterise the load cell, I designed an automated measuring station and successfully carried out the required measurements using the LabVIEW software. The measurements confirmed the excellent characteristics on a series of prototype load cells, including a small nonlinearity and hysteresis error and a large output.

Studying at the Jožef Stefan International Postgraduate School, I had the opportunity to follow the newest achievements in my research field, as well as the possibility to widen my knowledge onto other interesting research fields.

Študijski program EKOTEHNOLOGIJA

Prof. dr. Milena Horvat
Predstojnica študijskega programa *Ekotehnologija*
Head of the Ecotechnology Programme

TEMELJNA OPREDELITEV PROGRAMA

Ekotehnologija je znanost, ki ob čim manjšem ogrožanju okolja, predvsem z učinkovitim vključevanjem naravnih procesov, podpira napore za pokrivanje potreb človeštva v harmoniji s celotno naravo.

Ker je usmerjena v reševanje realnih problemov, kar terja celovit pristop, je za ekotehnologijo značilno povezovanje dosežkov številnih naravoslovnih, tehnoloških in družboslovnih ved z usmeritvijo v trajnostni razvoj. Zato je multidisciplinarni pristop značilnost študijskega programa Ekotehnologija. Poudarjena sta **eko**loški in **eko**nomski pristop.

Žeja pri delu na ladji
Thirst after work on deck

Study Programme ECOTECHNOLOGY

BASIC DEFINITION OF THE PROGRAMME

***Ecotechnology** is a field of science that supports the efforts to meet the demands of mankind in harmony with Nature by causing as little damage to the environment as possible, in particular by the efficient implementation of natural processes.*

*Due to its problem-solving orientation, which demands a comprehensive approach, ecotechnology is characterised by the integration of achievements from numerous natural, technological and social sciences, with a focus on sustainable development. A multidisciplinary approach is therefore one of the characteristics of the Ecotechnology programme. The emphasis is on **eco**logical and **eco**nomic approaches.*

Delo v odlično opremljenih laboratorijih za organsko analizno kemijo Instituta »Jožef Stefan« je tudi zabavno.
The work in the well-equipped laboratories for organic analytical chemistry of the Jožef Stefan Institute can also be fun.

UMEŠČENOST PROGRAMA V POTREBE UPORABNIKOV

Slovenija je vgradila načela trajnostnega razvoja v svojo temeljno razvojno strategijo, ki jo podpira z vrsto pravnih, ekonomskih, ekoloških in socialnih ukrepov. Deficit je pri uveljavljanju teh ukrepov in integraciji njihovih učinkov, predvsem zaradi pomanjkanja trajnostno usmerjenih in vrhunsko usposobljenih vodstvenih kadrov. Z vključevanjem Slovenije v Evropsko unijo je porasla zahteva po kompetitivnosti na vseh področjih. V gospodarstvu, storitvenih dejavnostih in v javnih službah terja hitrejši in učinkovitejši razvoj in prenos ekotehnologij ter uveljavlja odločnejšo usmeritev k trajnostnemu razvoju. V znanosti in izobraževanju je bistveno večji poudarek na prenosu znanja ob povezovanju temeljnih raziskav z razvojnimi na vseh področjih. Nujno je načrtovati, razviti in širiti uporabo ekotehnologij in z načrtnimi trajnostno usmerjenimi tržnimi strategijami razvijati ugodnejša gibanja porabe.

V okviru mednarodnih projektov GEOTRACES in GMOS ter raziskovalne ekspedicije z ladjo James Cook v lasti Univerze Oxford iz Velike Britanije je dr. Arne Bratkič opravil analize živega srebra v vodnem stolpcu južnega Atlantika. Analize so pokazale izrazito zmanjšanje koncentracij raztopljenega elementarnega Hg (DGM = dissolved gaseous mercury) v površinskih slojih, ki je posledica intenzivnega izhlapevanja v zrak. Zaradi teh procesov so oceani bistveni naravni vir Hg v globalni atmosferi.

In the framework of the international projects GEOTRACES and GMOS, and with the research expedition on the James Cook ship owned by Oxford University, UK, Dr. Arne Bratkič carried out analyses of mercury in the water column of the South Atlantic. The analyses showed a distinct decrease in the concentrations levels of dissolved elementary Hg (DGM) in the surface layers as a consequence of intensive vaporization. As a result of these processes, the oceans are essential natural sources of Hg in the global atmosphere.

PROGRAMME IN RELATION TO USER NEEDS

Slovenia integrated the principles of sustainable development into its basic development strategy and supports it with a number of legal, economic, ecological and social measures. A deficit was shown in implementing these measures and integrating their effects, especially due to the lack of sustainable-development-oriented and highly qualified managerial staff. With the accession of Slovenia to the European Union, the need for competitiveness increased in all fields. In the economy, service industries and public services it demands a faster and more efficient development and the transfer of ecotechnologies, as well as a more determined orientation towards sustainable development. In science and education, considerably more emphasis is placed on knowledge transfer by bringing together basic and development research in all fields. It is essential to plan, develop and spread the use of ecotechnologies and to develop better trends in consumption, with planned, sustainable-development-oriented market strategies.

Laboratorijsko delo na ladji James Cook

Laboratory work on the James Cook ship

CILJI ŠTUDIJSKEGA PROGRAMA

Strategija trajnostnega razvoja vključuje integracijo okoljskih, tehnoloških, ekonomskih in socialnih ciljev, posebej v proizvodnji in potrošnji.

Študijski program nudi pridobivanje znanj in razvoj spretnosti za kompetentno raziskovanje, mednarodno povezovanje in vodenje trajnostno usmerjenega razvoja, prenosa in uporabe ekotehnologij. Poudarek je na trojni usposobljenosti:

- širjenje in poglabljanje znanstvene vsebine, metod in tehnik na izbranih področjih naravoslovnih znanosti, tehnologij, inženirstva in informatike, ki bo podpiralo strateško izbiro, razvoj, prenos, optimizacijo, izkoriščanje in nadzor izbranih ekotehnologij za večjo poslovno učinkovitost ob hkratnem zadovoljevanju širših družbenih interesov za trajnostni razvoj;

- razvoj sposobnosti in spretnosti za dvig kakovosti procesov, proizvodov in storitev ter višanje dodane vrednosti ob stremljenju k odličnosti in maksimalnemu uveljavljanju načel trajnostnega razvoja;

- razvoj integralnega načina mišljenja, ki presega posamezna področja in razvija sposobnosti za komunikacijo s strokovnjaki drugih disciplin in področij, celovito opredelitev problemov, sistemske pristope in reševanje zapletenih problemov v skupinskem delu, odločanje v pogojih negotovosti ter dolgoročno usmerjeno strateško načrtovanje. V ta namen so v program vključena tudi izbrana menedžerska znanja in razvijanje spretnosti za uporabo znanja v reševanju širših ekonomskih, okoljskih, socio-političnih, regulativnih in upravljavskih problemov.

Terensko delo – meritve koncentracij radona v talnem zraku

Field work – measuring the radon concentration in soil gas

OBJECTIVES OF THE STUDY PROGRAMME

The strategy of sustainable development includes the integration of environmental, technological, economic and social objectives, especially in production and consumption.

The study programme offers the acquisition of knowledge and the development of skills for competent research, forming international relationships, and for the management of sustainability-oriented development, together with the transfer and application of ecotechnologies. The emphasis is placed on a threefold ability for:

- *widening and deepening the scientific content, methods and techniques in the selected fields of natural sciences, technologies, engineering and information sciences, which will support the strategic choice, development, transfer, optimization, utilization and control of selected ecotechnologies for increasing commercial efficiency, while benefiting the broader social interests concerning sustainable development;*

- *developing the abilities and skills for enhancing the quality of processes, products and services, and increasing the added value by striving for excellence and the maximum enforcement of the principles of sustainable development;*

- *developing an integral process of thinking that surpasses individual areas and develops multidisciplinary communication skills for dealing with experts from other disciplines and subject areas, a comprehensive definition of problems, systematic approaches and solving complex problems through teamwork, decision-making under conditions of uncertainty, and long-term, target-oriented strategic planning. For this purpose, the programme also includes selected topics from management and the development of skills for the application of acquired knowledge to solving larger economic, environmental, socio-political, regulative and management problems.*

Izpisovanje podatkov z merilnega instrumenta za meritve koncentracije radona v Postojnski jami
Printing the data from a measuring instrument for measuring radon concentrations in the Postojna Cave

IZVAJANJE ŠTUDIJSKEGA PROGRAMA

Študijski program Ekotehnologija je usidran v razvojne projekte za ekotehnološko prenovo in napredek v proizvodnji, storitvenih dejavnostih in javnih službah. Program poudarja ekonomsko učinkovitost ob varovanju okolja, zlasti tako, da podpira:

- ozaveščanje o potrebi gospodarstva za višanje učinkovitosti izbora in uporabe materialov in virov energije,
- nadzor nad učinki procesov na ekosisteme,
- razvoj in nenehno izboljševanje čistejših postopkov in proizvodov, ki vključujejo večanje učinkovitosti uporabe surovin in energije, minimizacijo in reciklažo odpadkov, zmanjšanje negativnih učinkov proizvodnje in transporta na okolje ter načrtno izboljševanje ogroženega okolja,
- uvajanje eko-trženja,
- uveljavljanje sistemov za okoljsko upravljanje v proizvodnji, storitvah in javnem sektorju,
- najširše ozaveščanje o nuji za varovanje okolja in uveljavljanje načel trajnostnega razvoja.

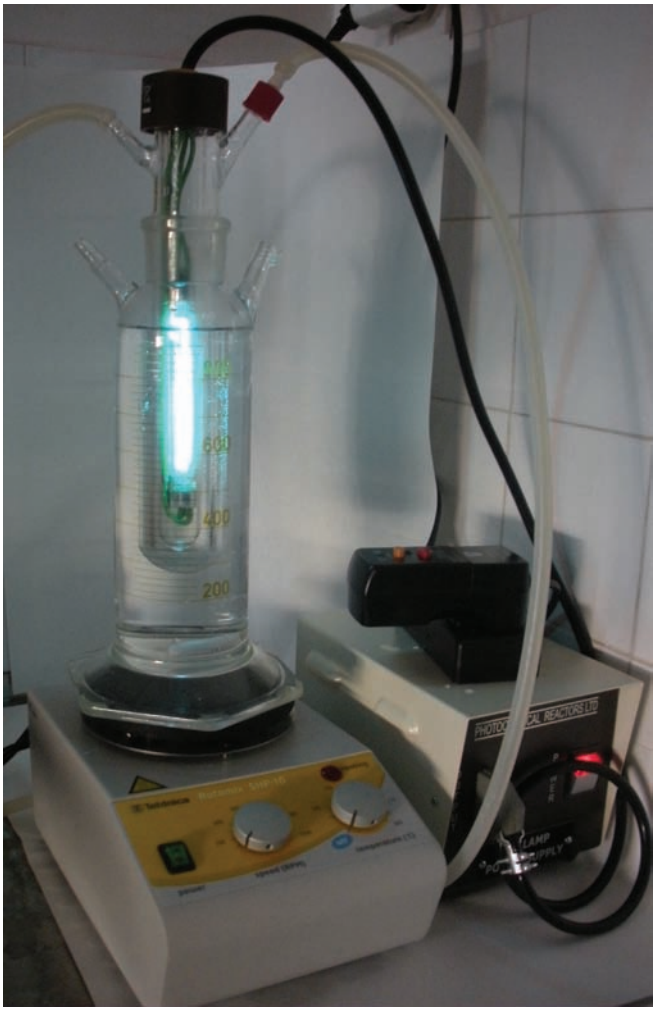
Johanna Robinson v okviru magistrskega dela sodeluje na projektu 7.OP CITI-SENSE »Development of Sensor-based Citizens' Observatory Community for Improving Quality of Life in Cities«, katerega namen je opolnomočenje prebivalcev v smislu izboljšanja kakovosti zraka v Ljubljani. Na sliki je dan odprtih vrat Instituta »Jožef Stefan«, kjer je bilo zanimanje za projekt precejšnje, zlasti med mladimi obiskovalci, ki so jih pritegnili predvsem napredni senzorski sistemi in pametne tehnologije prenosa podatkov o kakovosti notranjega in zunanjega zraka.

In the framework of her master's thesis, Johanna Robinson works on the CITI-SENSE 7th framework programme entitled »Development of Sensor-Based Citizens' Observatory Community for Improving Quality of Life in Cities«. The aim of the programme is to empower citizens in terms of improving the quality of air in Ljubljana. The photograph shows the Jožef Stefan Institute opening its doors to visitors. The project raised great interest, in particular among younger visitors, who were fascinated by the sensor systems and intelligent technologies behind the transfer of data on the quality of the indoor and outdoor air.

IMPLEMENTATION OF THE STUDY PROGRAMME

The Ecotechnology study programme is incorporated into the development projects for ecotechnological reform and progress in production, the service industries and public services. The programme emphasises the economic efficiency in environmental protection, especially by:

- *raising awareness of the economic demand for increasing the efficiency of the selection and use of materials and sources of energy,*
- *monitoring the effects of processes on ecosystems,*
- *developing and constantly improving cleaner procedures and products that incorporate increasing the efficiency of raw materials and energy consumption, waste minimisation and recycling, the reduction of negative impact from production and transport on the environment and planned improvements of endangered environments,*
- *introducing eco-marketing,*
- *implementing the systems for environmental management in production, services and the public sector,*
- *spreading awareness of the importance of environment protection and implementing the principles of sustainable development.*



Fotoreaktor

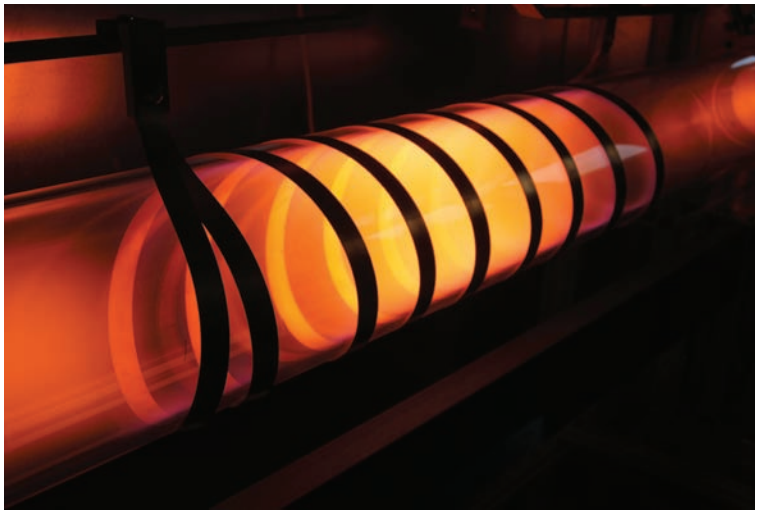
Photoreactor

PRIMERI DOSEŽKOV

Predstavljeni primeri kažejo značilnosti raziskovalno usmerjenega podiplomskega izobraževanja v okviru programa MPŠ: Ekotehnologija.

- **Razvoj in izdelava večjega plazemskega reaktorja za okolju prijazno funkcionalizacijo polizdelkov in komponent**

Dr. Rok Zaplotnik je v okviru disertacije z naslovom **Optimizacija sklopa med visokofrekvenčnim generatorjem in nizkotlačno plazmo** (mentor prof. dr. Miran Mozetič) razvil plazemski reaktor, ki je primeren za obdelavo večjih kosov dolžine do 2 m ali množice manjših obdelovancev. Izvirno rešitev sklopitve je zaščitil s prijavo mednarodnega patenta z oznako »WO2012099548 – Device for high-frequency gas plasma excitation 2012« avtorjev Zaplotnik Rok, Vesel Alenka in Mozetič Miran in v istem avtorstvu objavil članek A fiber optic catalytic sensor for neutral atom measurements in oxygen plasma. *Sensors*, 2012, 12, 4, 3857-3867. Raziskovalne dosežke je doslej objavil v 19 znanstvenih člankih.



Nizkotlačna plazma je močan izvir kemijsko reaktivnih radikalov.

A low-pressure gaseous plasma is an extensive source of chemically reactive radicals.

- **Prisotnost in čiščenje ostankov zdravilnih učinkovin v okolju**

Čeprav vpliv ostankov zdravilnih učinkovin v okolju še ni poznan v celoti, že povzroča naraščajočo zaskrbljenost in prinaša nov izziv za čiščenje pitnih in odpadnih vod ter za njihovo ponovno uporabo. Teme v okviru doktorskih nalog **dr. Tine Kosjek**, **dr. Mojce Zupanc** in **dr. Mihe Avberška** pod mentorskim vodstvom prof. dr. Ester Heath so zajemale identifikacijo in karakterizacijo teh spojin ter metode za njihovo učinkovito odstranjevanje. Dela so bila objavljena v 24 znanstvenih člankih, med njimi tudi v članku v vrhunski reviji na področju okoljskih znanosti Environmental Science & Technology – Kosjek Tina, Andersen Henrik R., Kompare Boris, Ledin Anna, Heath Ester. Fate of carbamazepine during water treatment. *Environmental science & technology*, 2009, 16, 43, 6256-6261.

EXAMPLES OF ACHIEVEMENTS

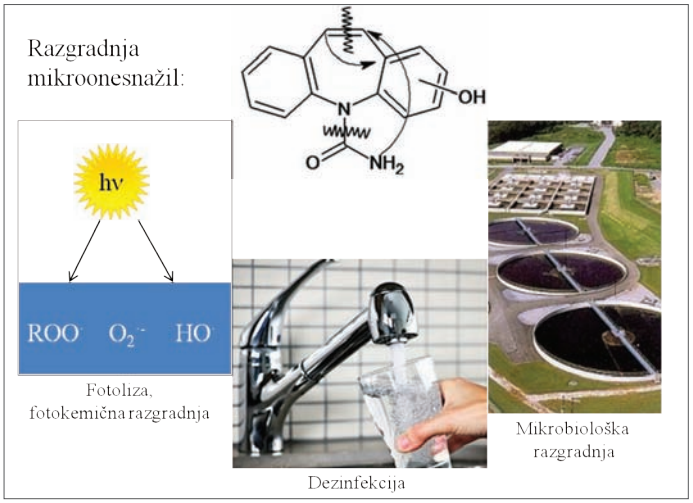
The presented examples show the characteristics of the research-oriented postgraduate studies within the IPS Ecotechnology programme.

- ***Development and construction of a large plasma reactor suitable for the environment-friendly functionalization of products and components***

*In his thesis entitled »**Optimization of coupling between a radio-frequency generator and a low-pressure gaseous plasma**« (Supervisor Associate Professor Miran Mozetič) **Dr. Rok Zaplotnik** presented results on the development of a plasma reactor suitable for the treatment of pieces up to 2 m long or numerous smaller samples. His innovative coupling has been protected with a patent application »WO2012099548 – Device for high-frequency gas plasma excitation (2012)«. The inventors are Dr. Rok Zaplotnik, Co-supervisor Assistant Professor Alenka Vesel and Supervisor Associate Professor Miran Mozetič. The scientific details about the behaviour of neutral oxygen atoms produced in such a gaseous plasma were published in the paper of the same authors entitled »A fiber optic catalytic sensor for neutral atom measurements in oxygen plasma. Sensors, 2012, 12, 4, 3857-3867«. Dr. Zaplotnik has already published 19 original scientific papers.*

- ***Presence and removal of pharmaceutical residues in the environment***

*Our understanding of the effects that pharmaceutical residues have on the environment is a subject that continues to grow in importance and presents new challenges for drinking and wastewater treatment and reuse. The subject of the theses of **dr. Tina Kosjek**, **dr. Mojca Zupanc** and, **dr. Miha Avberšek**, all under the supervision of Associate Professor Ester Heath, involved the identification, characterisation and removal of pharmaceutical residues. This research has been published in 24 scientific papers, including one paper in the renowned journal Environmental Science & Technology – Kosjek Tina, Andersen Henrik R., Kompare Boris, Ledin Anna, Heath Ester. Fate of carbamazepine during water treatment. Environmental Science & Technology, 2009, 16, 43, 6256-6261.*

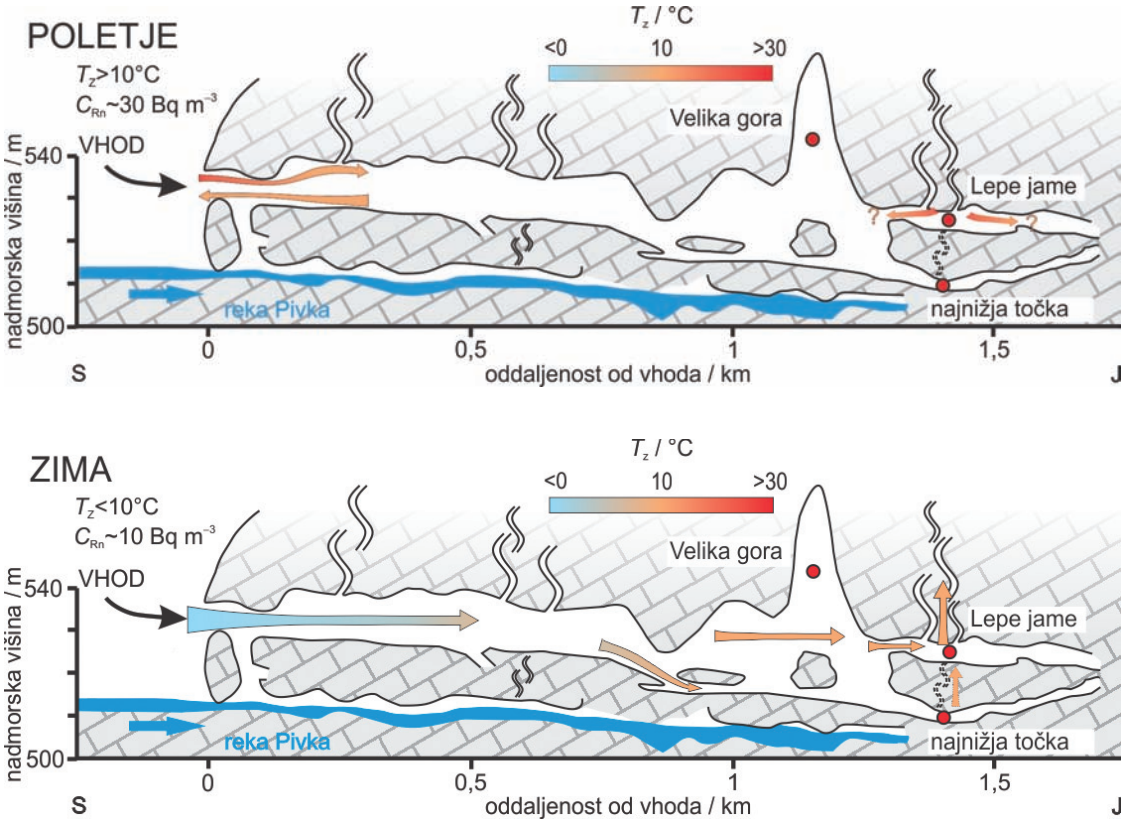


Med čiščenjem odpadnih in pitnih vod ali pod vplivom dejavnikov razgradnje v okolju prihaja do pretvorbe mikroonesnažil v produkte transformacije. Slika ponazarja glavne procese razgradnje: fotorazgradnja, dezinfekcija, mikrobiološka razgradnja.

During wastewater and drinking water treatment as well as under environmental degradation conditions micropollutants' transformation products are formed. Figure shows main processes involved, e.g. photodegradation, disinfection and microbiological degradation.

- **Radon v jamskem okolju**

Naravna radioaktivnost je v nekaterih območjih Slovenije povišana, kar lahko predstavlja problem v domovih in v naravnih podzemskih jamah. Meritve radona (Rn) omogočajo izračun letne povprečne efektivne doze in s tem ovrednotenje izpostavljenosti radonu v slovenskih domovih. Rezultati so pomembni pri načrtovanju rabe prostora in bivalnih okolij na ogroženih območjih. **Dr. Asta Gregorič** (mentorica prof. dr. Janja Vaupotič) pa je v disertaciji uporabila radon tudi pri geofizikalnih raziskavah, zlasti seizmologiji. Objavila je 14 znanstvenih člankov, med njimi: Gregorič Asta, Zidanšek Aleksander, Vaupotič Janja. Dependence of radon levels in Postojna Cave on outside air temperature. *Natural hazards and earth system sciences*, 2011, 11, 5, 1523-1528.



Prikaz gibanja zraka v Postojnski jami glede na temperaturo zunanjega zraka: poleti in pozimi

Air movement in Postojna Cave considering the outside air temperature: in summer and in winter

- ***Radon in a cave environment***

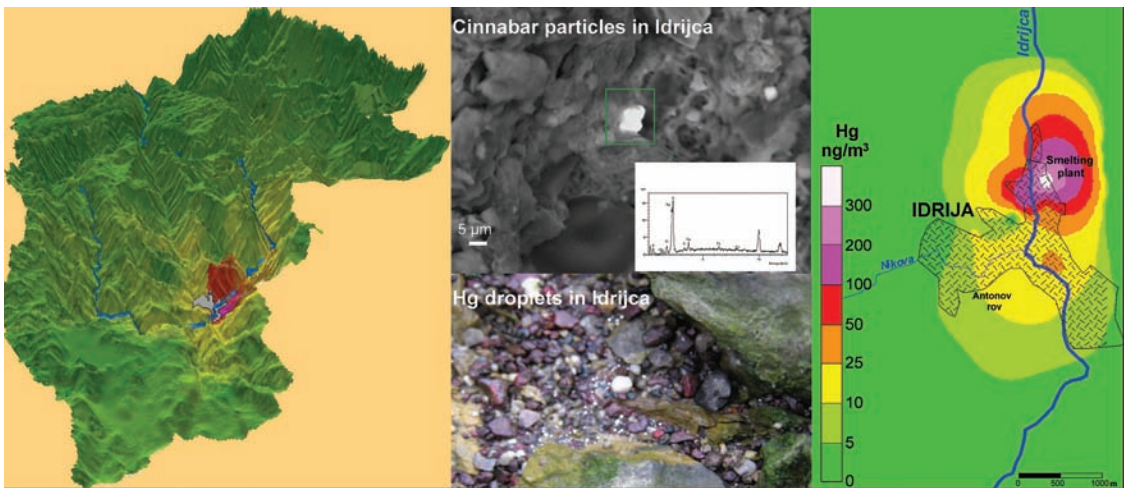
The levels of natural radioactivity are elevated in some areas of Slovenia; as a result, exposure to ionising radiation in a number of homes and workplaces, such as in the karst caves, is undesirably high. Radon (Rn) measurements provide the data needed to calculate the effective doses received by breathing radon and its short-lived products, which contribute more than half of the yearly dose due to all natural radioactive sources. These data are also important for the design and construction of new buildings and for reducing the radon levels in old ones. In her disseration ***Dr. Asta Gregorič*** *(Supervisor Associate Professor Janja Vaupotič) used radon as a tool in geophysical research, more specifically in seismology and tectonics. She has published 14 scientific papers. Example: Gregorič Asta, Zidanšek Aleksander, Vaupotič Janja. Dependence of radon levels in Postojna Cave on outside air temperature. Natural Hazards and Earth System Sciences, 2011, 11, 5, 1523-1528.*

NIB – Terenska raziskava gnezdidtvene biologije in ekologije kozače, *Strix uralensis* (Foto: P. V. Vrezec)

NIB – Field studies of Ural owl (Strix uralensis) ecology and breeding biology

- **Sledenje snovnih tokov živega srebra na kontaminiranih območjih**

Rudnik živega srebra v Idriji se je v svetovno zakladnico znanja zapisal z izjemnimi tehničnimi in kulturnimi dosežki. Po zaprtju pa je žal zapustil zelo onesnaženo območje, ki sega od Idrije do Tržaškega zaliva. Sledenje živega srebra na območju porečij Idrijce in Soče je bila tema doktorske naloge **dr. Davida Kocmana** (mentorica prof. dr. Milena Horvat), ki je preučeval prehode živega srebra med kopenskimi ekosistemi in vodnim okoljem ter izmenjavo z atmosfero. Tako sledenje terja poglobljeno poznavanje frakcionacije in speciacije živega srebra. Ta je osnova za razvoj integriranih modelov, ki so potrebni za prostorsko planiranje širšega porečja reke Idrijce in Soče. Dela so objavljena v 18 znanstvenih člankih, med njimi je objava v reviji Atmospheric Chemistry and Physics – Kocman David, Horvat Milena. A laboratory based experimental study of mercury emission from contaminated soils in the River Idrijca catchment. *Atmospheric Chemistry and Physics*, 2010, 10, 3, 1417-1426.



Modelno orodje za prenos živega srebra v širši okolici bivšega Rudnika živega srebra v Idriji je odlično orodje za načrtovanje remediacije onesnaženega okolja z živim srebrom.

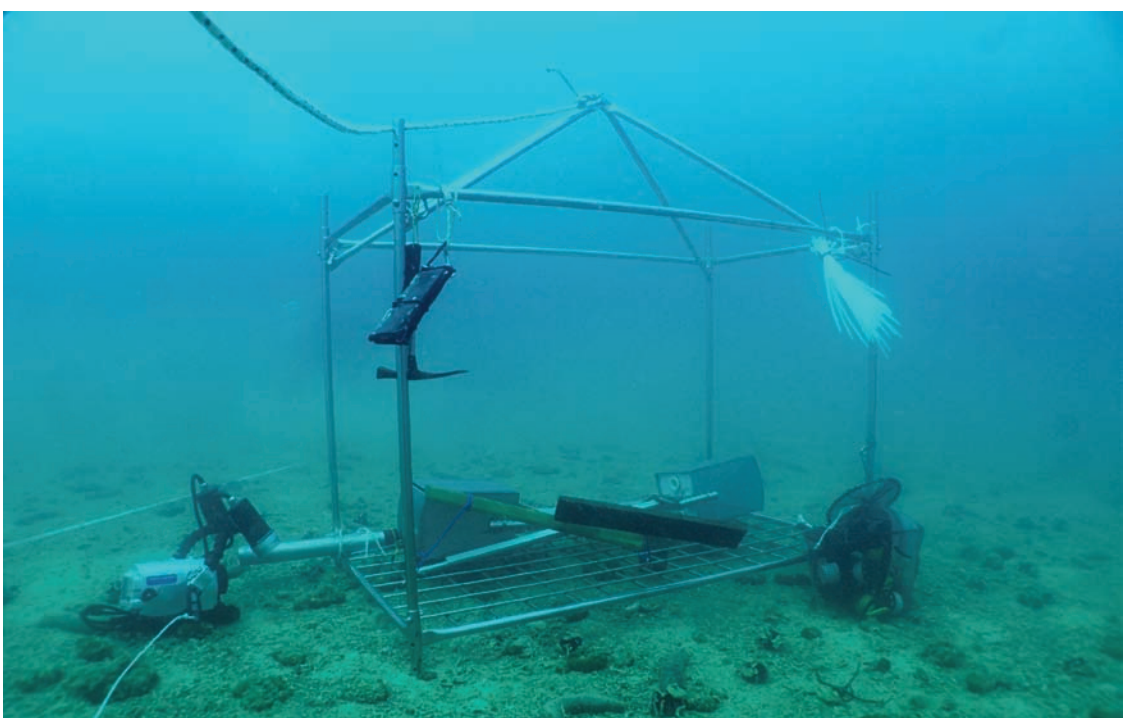
Modeling tools for the transfer of mercury in the surroundings of a former mercury mine in Idrija is a great tool for planning remediation of mercury polluted environments.

Metodologija, razvita v okviru doktorskega dela dr. Davida Kocmana, je bila osnova za izračun prispevne stopnje kontaminiranih okolij na globalni ravni. Ugotovljeno je bilo, da ta prispevek globalno znaša več kot 10 %, kar dokazuje, da ta okolja niso samo lokalna skrb, temveč tudi regionalnega in globalnega pomena. V pripravah nove globalne konvencije za živo srebro, Konvencija Minamata, ki je bila podpisana leta 2013, je dr. Kocman pripravil pomembne znanstvene podlage, ki so vplivale na obravnavo kontaminiranih okolij na svetovni ravni. Zajete so v objavi – Kocman David, Horvat Milena, Wilson Simon, Outridge Peter, Telemer Kevin. Global releases of mercury to aquatic environments. V: Bieber, Elke. *Technical background report for the global mercury assessment 2013*. UNEP – United Nations Environment Programme, 2013, 69-81.

- ***Tracing the mercury fluxes in contaminated systems***

The Idrija mercury mine is one of the world's treasures of knowledge, with exceptional technical and cultural achievements. However, centuries of mining have also resulted in the widespread contamination of the area, which extends from the town of Idrija to the Gulf of Trieste. Tracing the mercury cycling in the Idrijca River catchment was the topic of the doctoral thesis of ***Dr. David Kocman*** *(Supervisor Professor Milena Horvat), who studied mercury transfers between terrestrial ecosystems and the aquatic environment, and its exchange with the atmosphere. In order to achieve these goals, an in-depth knowledge of the fractionation and speciation of the mercury was needed. This knowledge serves as a basis for the development of integrated models, which are further necessary for the spatial planning and management of the Idrijca and Soča rivers. The results of this work have been published in 18 scientific papers, including a publication in Atmospheric Chemistry and Physics – Kocman David, Horvat Milena. A laboratory based experimental study of mercury emission from contaminated soils in the River Idrijca catchment. Atmospheric Chemistry and Physics, 2010, 10, 3, 1417-1426.*

The methodology developed in the framework of the doctoral dissertation of Dr. David Kocman was the basis for a calculation of the contribution of a contaminated system to the global mercury budget. The results revealed that these systems contribute significantly, indicating not only their local but also their regional and global-scale importance. Within the preparation of the Minamata Convention on Mercury, an international treaty on mercury signed in 2013, Dr. David Kocman was part of the expert group preparing the technical background report that the convention is based on. His contribution resulted in the following publication – Kocman David, Horvat Milena, Wilson Simon, Outridge Peter, Telemer Kevin. Global releases of mercury to aquatic environments. V: Bieber, Elke. Technical background report for the global mercury assessment 2013. UNEP – United Nations Environment Programme, 2013, 69-81.



NIB – Ploščad z opremo za podvodno raziskovanje (Foto: B. Mavrič)

NIB – Stand with equipment for underwater research

- **Identifikacija optimalnih kmetijskih praks v vodovarstvenih pasovih**

Uporaba stabilnih izotopov dušika ($K^{15}NO_3$) za sledenje migracije nitrata v sistemu rastlina–tla–podzemna voda s pomočjo markiranega gnojila je bila tema doktorske naloge **dr. Martine Burnik Šturm** (mentorica prof. dr. Sonja Lojen). Izkazalo se je, da je kmetova praksa, ki sloni na založnem gnojenju in zalivanju po potrebi, najučinkovitejša, posebej na vodovarstvenih pasovih. Dela na področju rabe stabilnih izotopov je objavila v 12 znanstvenih člankih. Velik uporabni potencial ima zlasti članek: Burnik Šturm Martina, Kacjan-Maršić Nina, Lojen Sonja. Can ^{15}N in lettuce tissues reveal the use of synthetic nitrogen fertiliser of inorganic production? *Journal of the Science of Food and Agriculture*, 2011, 91, 2, 262-267.

Lončni poskus v rastlinjaku, s katerim smo ugotavljali vpliv kombinirane uporabe in načina dognojevanja solate z različnimi organskimi in sintetičnimi gnojili na izotopsko sestavo dušika v solati.

Greenhouse experiment, where the influence of the combined use and application regime of organic and synthetic fertilizers on the nitrogen stable isotope composition of lettuce was studied.

- **Določitev izvora policikličnih aromatskih ogljikovodikov v okolju**

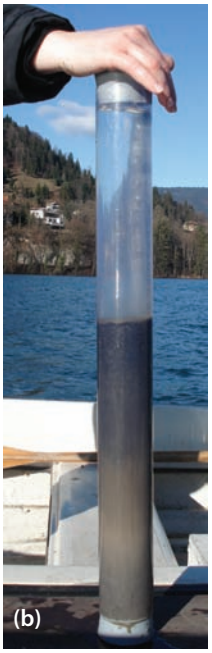
Uporaba stabilnih izotopov v okoljskih študijah ima vedno večji pomen. **Dr. Marinka Gams Petrišič** (mentorica prof. dr. Nives Ogrinc) je v svojem doktorskem delu bistveno prispevala k razvoju metode za določanje izvora najbolj razširjenih organskih polutantov – policikličnih aromatskih ogljikovodikov (PAH) – v okolju, ki temelji na določitvi izotopske sestave ogljika v posameznih PAH-ih. V sedimentih Blejskega jezera je raziskala izvor in transformacijske procese. Ugotovila je, da so nekateri PAH-i v anoksičnih okoljih stabilni in zato uporabni pri identifikaciji paleo-okoljske dejavnosti onesnaževanja. Med petimi objavami je zlasti pomembno delo objavljeno v ugledni reviji Environmental Science and Technology – Gams Petrišič Marinka, Muri Gregor, Ogrinc Nives. Source identification of polycyclic aromatic hydrocarbons in Lake Bled (NW Slovenia) sediments using stable carbon isotopes. *Environmental Science & Technology*, 2013, 47, 1280-1286.

- ***Identification of optimal agricultural practices in water-protection areas***

The topic of the PhD thesis of ***Dr. Martina Burnik Šturm*** *was the use of nitrogen-stable isotopes ($K^{15}NO_3$) for the tracing of nitrate migration in the plant-soil–groundwater system using a labelled fertiliser. It was shown that the farming practise, based on broadcast application and irrigation when needed, is the most appropriate, in particular in water protection zones on alluvial aquifers. Dr. Martina Burnik Šturm published her research in 12 scientific papers. The applied value of her work is shown in the paper Burnik Šturm Martina, Kacjan-Maršić Nina, Lojen Sonja. Can ^{15}N in lettuce tissues reveal the use of synthetic nitrogen fertiliser of inorganic production? Journal of the Science of Food and Agriculture, 2011, 91, 2, 262-267.*

- ***Determination of the sources of polycyclic aromatic hydrocarbons in the environment***

The use of stable isotopes in environmental studies has recently received more attention. In her disseration ***Dr. Marinka Gams Petrišič*** *(Supervisor Associate Professor Nives Ogrinc) has significantly contributed to the development of methods for determining the origin of the most widespread organic pollutants – polycyclic aromatic hydrocarbons (PAHs) – in the environment. The method, based on the determination of the stable carbon isotope composition of individual PAHs, was successfully applied in the lacustrine sediments of Lake Bled and could be used to trace and identify the sources and transformation processes of PAHs in the environment. It was demonstrated that some PAHs were resistant to weathering reactions in anoxic sediments and thus useful in the identification of palaeo-environmental pollution activities. Among five publications, the most important was the paper published in the prestigious journal Environmental Science and Technology – Gams Petrišič Marinka, Muri Gregor, Ogrinc Nives. Source identification of polycyclic aromatic hydrocarbons in Lake Bled (NW Slovenia) sediments using stable carbon isotopes. Environmental Science & Technology, 2013, 47, 1280-1286.*

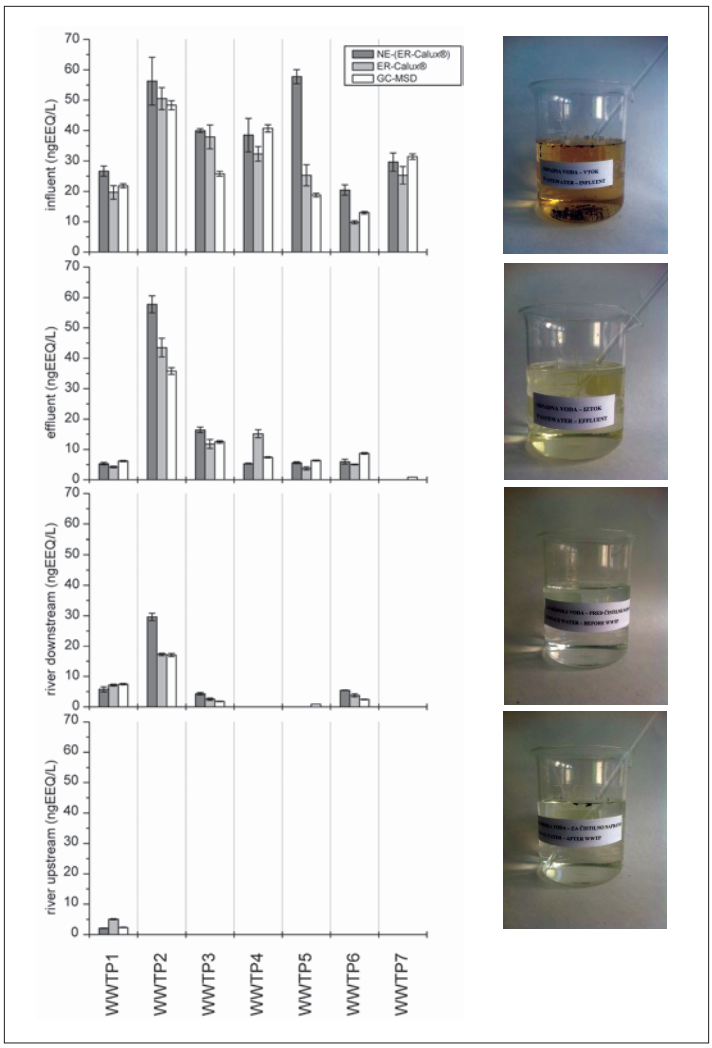


(a) Področje raziskav: Blejsko jezero (SZ Slovenije). (b) Vzorec jedra sedimenta odvzetega v zahodni kotanji Blejskega jezera

(a) Location of investigation: Lake Bled (NW Slovenia). (b) Sediment core sample from the West Basin of Lake Bled

- **Kemijske in biološke metode za diagnostiko stanja v okolju**

V sodelovanju z Nacionalnim inštitutom za biologijo je **dr. Miha Avberšek** (mentorica prof. dr. Ester Heath) v disertaciji uspešno združil kemijsko (ekstrakcija na trdnem nosilcu, plinska kromatografija z masno spektrometrijo) in biološko analizo (ER-Calux® s predhodno ekstrakcijo vzorcev in brez nje) steroidnih estrogenov v vzorcih iz okolja. Uporabnost metode je preveril na umetnih in dejanskih vzorcih iz čistilnih naprav. Pokazal je, da hitra metoda brez predhodne ekstrakcije daje primerljive rezultate kot kemijska analiza in običajen ER-Calux® test, pri čemer s preprosto pripravo vzorca in manjšim volumnom vzorca skrajša čas in stroške analize za 95 %. Na osnovi teh rezultatov napoveduje uporabnost modificiranega ER-Calux® testa kot presejalnega testa, pri čemer naj bi se zahtevno kemijsko analizo omejilo zgolj na kritičnih vzorcih. Rezultati so opisani v članku v reviji Journal of Hazardous Materials – Avberšek Miha, Žegura Bojana, Filipič Metka, Uranjek Ževart Nataša, Heath Ester. Determination of estrogenic potential in waste water without sample extraction. *Journal of Hazardous Materials*, 2013, 260, 527-533. Skupaj je v okviru disertacije objavil tri članke.



Estrogeni potencial v vtokih in iztokih sedmih čistilnih naprav ter v pripadajočih površinskih vodah (dolvodno in gorvodno od čistilne naprave), določen z biološkimi (NE-(ER-Calux®) in ER-Calux®) in kemijskimi metodami (GC-MSD)

Estrogenic potential of »real« samples from seven WWTPs, tested with biological tests (NE-(ER-Calux®) and ER-Calux®) and chemical analysis (GC-MSD) in influent, effluent and river samples (downstream and upstream from WWTP)

- ***Chemical and biological methods for diagnosing environmental conditions***

In his dissertation ***Dr. Miha Avberšek*** *(Supervisor Associate Professor Ester Heath), in collaboration with the National Institute of Biology, has successfully modified the estrogenicity assay ER-Calux® to be able to test raw wastewater samples without the need for sample extraction. This method has been compared to the ER-Calux® assay and estrogenicity derived from the analysis of four known estrogens by GC-MSD. His results show no statistical difference between the results obtained by NE-ER-Calux and the other two methods. In addition, the new method significantly reduces the analysis time and costs by 95%. On the basis of these results, he expects high applicability of the modified ER-CALUX® assay as a screening test, where demanding chemical analyses can be performed only on critical samples. The results of this study were published in the Journal of Hazardous Materials – Avberšek Miha, Žegura Bojana, Filipič Metka, Uranjek Ževart Nataša, Heath Ester. Determination of estrogenic potential in waste water without sample extraction. Journal of Hazardous Materials, 2013, 260, 527-533. Altogether, Dr. Miha Avberšek published his PhD research in three scientific papers.*

NIB – Vzorčenje jamske vodne favne v Veliki Pasici pri Igu (Foto: A. Brancelj)

NIB – Sampling of aquatic cave fauna in the cave Velika Pasica near Ig

- **Uporaba prahu iz elektroobločne peči v cementnih kompozitih: ocena okoljskih vplivov**

Dr. Tina Oblak je v okviru disertacije raziskovala problematiko filtrskega prahu iz elektroobločne peči (EAF) (mentor prof. dr. Janez Ščančar, somentor prof. dr. Radmila Milačič), ki je odpadni material pri predelavi jekla in se ga v glavnem odlaga na odlagališča odpadkov. Preučevala je uporabnost EAF prahu za pripravo cementnih kompozitov v gradbeništvu. Na podlagi izlužitvenih testov je ugotovila, da cementne kompozite, ki smo jim dodali do 1,5 % EAF prahu, lahko uporabljamo v gradbeništvu. Skupaj je s sodelavci v okviru disertacije objavila tri članke. Oblak Tina, Milačič Radmila, Murko Simona, Vahčič Mitja, Mladenovič Ana, Strupi-Šuput Jerneja, Ščančar Janez. The use of EAF dust in cement composites: assessment of environmental impact. *Journal of Hazardous Materials*, 2009, 166, 1, 277-283.

Predelava jekla v elektroobločni peči

The production of steel in an electricarc furnace

- **Organokositrove spojine v izcednih vodah z deponij odpadkov**

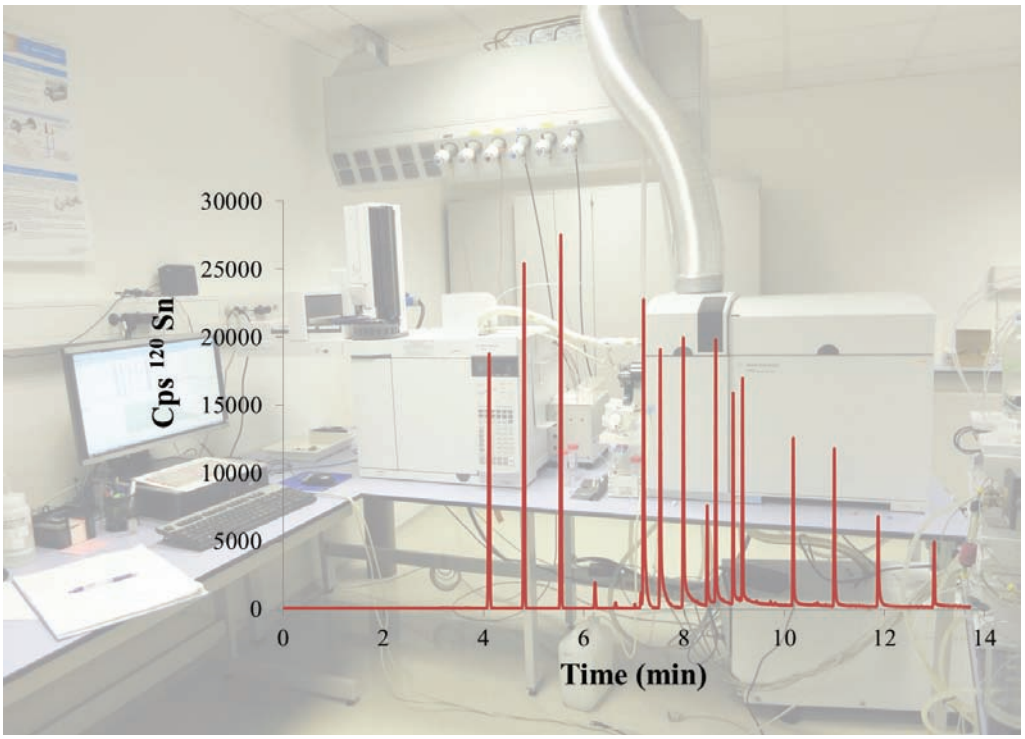
Organokositrove spojine (OTC) predstavljajo skupino strupenih snovi, ki jih je človek vnesel v okolje in spadajo med motilce hormonskega sistema. Že pri izjemno nizkih koncentracijah povzročajo negativne učinke. Zaradi tega je uporaba teh snovi, zlasti v morskem okolju, močno omejena. **Dr. Mitja Vahčič** (mentor prof. dr. Janez Ščančar) je v disertaciji osredotočen na razvoj metod za določanje organokositrovih spojin v izcednih vodah z deponij odpadkov. Določanje OTC v tej kompleksni matrici še ni ustrezno raziskano. Razvit je bil enostaven analizni postopek za simultano določitev metil-, butil-, fenil- in oktil-kositrov. Pri tem je bila uporabljena metoda plinske kromatografije v povezavi z masno spektrometrijo z induktivno sklopljeno plazmo (GC-ICP-MS). V sklopu disertacije je objavil šest člankov. Primer: Vahčič Mitja, Milačič Radmila, Ščančar Janez. Development of analytical procedure for the determination of methyltin, butyltin, phenyltin and octyltin compounds in landfill leachates by gas chromatography-inductively coupled plasma mass spectrometry. *Analytica Chimica Acta*, 2011, 694, 1, 21-30.

- ***The use of electric-arc filter dust in cement composites: an environmental impact assessment***

In her dissertation ***Dr. Tina Oblak*** *(Supervisor Professor Janez Ščančar, Co-supervisor Professor Radmila Milačič) studied problems related to electric-arc filter (EAF) dust. EAF dust is a by-product of the steel-making industry and is commonly landfilled. The potential for the use of EAF dust in cement composites in civil engineering was evaluated. Based on leachability tests, she found that the cement composites to which 1.5 % by mass of EAF dust has been added can be used in civil engineering. With co-workers she published three articles. Oblak Tina, Milačič Radmila, Murko Simona, Vahčič Mitja, Mladenovič Ana, Strupi-Šuput Jerneja, Ščančar Janez. The use of EAF dust in cement composites: assessment of environmental impact. Journal of Hazardous Materials, 2009, 166, 1, 277-283.*

- ***Organotin compounds in landfill leachate***

Organotin compounds (OTCs) represent a most hazardous group of substances that have been ever introduced into the environment by man. They are toxic at extremely low concentrations. For this reason, the use of these substances is strictly limited, in particular in the marine environment. In his dissertation ***Dr. Mitja Vahčič*** *(Supervisor Associate Professor Janez Ščančar) developed analytical procedures for the determination of OTCs in landfill leachates, which has not been reported so far. A simple analytical procedure for the simultaneous speciation analysis of methyl-, butyl-, phenyl- and octyl-tins in landfill leachates by gas chromatography coupled to inductively coupled plasma mass spectrometry (GC-ICP-MS) was developed. With co-workers he has published six articles. Example: Vahčič Mitja, Milačič Radmila, Ščančar Janez. Development of analytical procedure for the determination of methyltin, butyltin, phenyltin and octyltin compounds in landfill leachates by gas chromatography-inductively coupled plasma mass spectrometry. Analytica Chimica Acta, 2011, 694, 1, 21-30.*

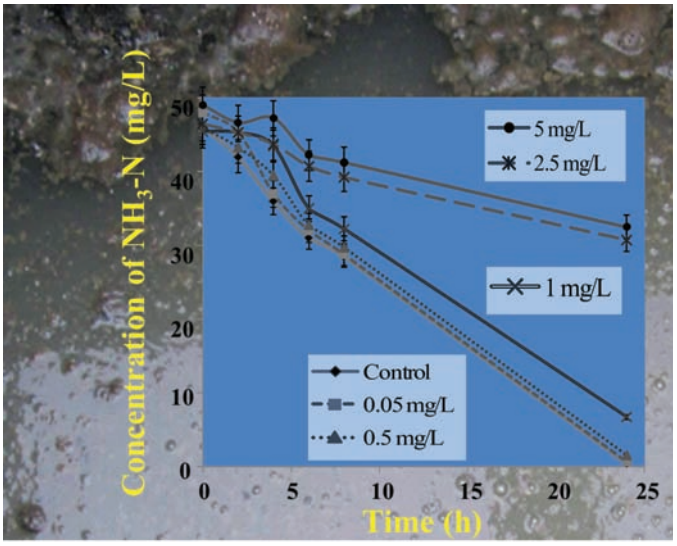


Kromatogram ločbe organokositrovih spojin v izcednih vodah z deponij odpadkov z GC-ICP-MS

Chromatogram of the separation of organotin compounds in landfill leachates by GC-ICP-MS

- **Inhibicija nitrifikacije v aktivnem blatu s trivalentnim in šestvalentnim kromom**

Šestvalentni krom (Cr(VI)) je pogosto onesnažilo v industrijskih odpadnih vodah, ki dotekajo na čistilne naprave. Odpadne vode z visoko koncentracijo kroma lahko zmanjšajo ali celo ustavijo mikrobno aktivnost pri čiščenju odpadnih vod. **Dr. Breda Novotnik** (mentorica prof. dr. Radmila Milačič) je v disertaciji preučevala, kako različne koncentracije Cr(VI) in Cr(III) vplivajo na enega najpomembnejših procesov v čistilnih napravah – nitrifikacijo aktivnega blata. Študija je prispevala nove izsledke o strupenosti zvrsti kroma in njihovih negativnih vplivih na nitrifikacijo ter o usodi Cr(VI) v aktivnem blatu. Ti podatki so zelo pomembni za upravljavce čistilnih naprav, saj lahko na podlagi analiznih izsledkov preprečijo dotok Cr(VI) v koncentracijah, ki so strupene za bakterije v aktivnem blatu. Objavila je pet člankov, med njimi: Novotnik Breda, Zuliani Tea, Ščančar Janez, Milačič Radmila. Inhibition of the nitrification process in activated sludge by trivalent and hexavalent chromium, and partitioning of hexavalent chromium between sludge compartments. *Chemosphere*, 2014, 105, 87-94.



Inhibicija nitrifikacije v aktivnem blatu s Cr(VI)

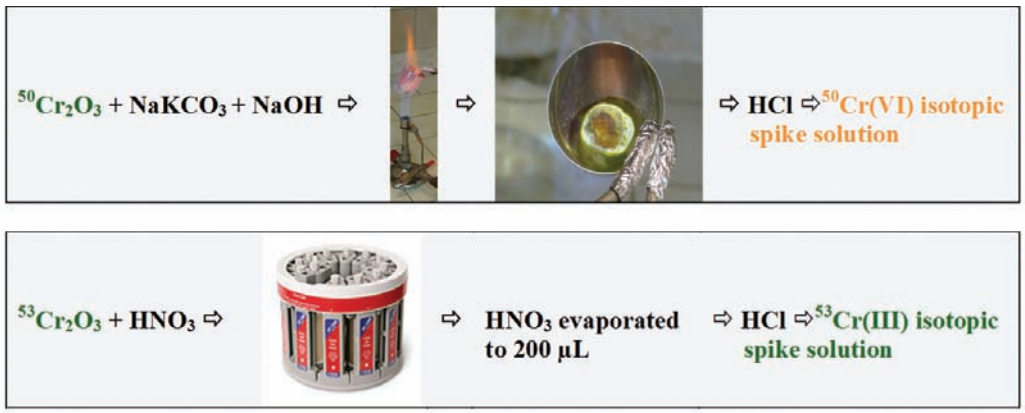
Inhibition of nitrification by Cr(VI) in activated sludge

Dr. Breda Novotnik je raziskovala tudi analizne vidike speciacije kroma. Osredotočila se je na pravilno pripravo izotopsko označenih kromovih zvrsti, saj je znano, da pri pripravi teh spojin lahko prihaja do artefaktov. Razvila je dva nova analizna postopka, ki temeljita na razkroju obogatenih izotopov kromovega trioksida. ^{50}Cr(VI) je pripravila z alkalno talino, kjer je kvantitativno oksidacijo ^{50}Cr(III) do ^{50}Cr(VI) dosegla z zračnim kisikom pri visoki temperaturi in visokem pH brez dodanih drugih oksidacijskih reagentov. ^{53}Cr(III) pa je pripravila s kislinskim razkrojem s pomočjo mikrovalov. Študija je pokazala, da je pravilna priprava izotopskih raztopin ^{53}Cr(III) in ^{50}Cr(VI) bistvena za njihovo nadaljnjo uporabo v okoljskih študijah. Primer članka: Novotnik Breda, Zuliani Tea, Martinčič Anže, Ščančar Janez, Milačič Radmila. Preparation of Cr(VI) and Cr(III) isotopic spike solutions from ^{50}Cr and ^{53}Cr enriched oxides without the use of oxidizing and/or reducing agents. *Talanta*, 2012, 99, 83-90.

- ***Inhibition of nitrification in activated sludge with trivalent and hexavalent chromium***

Hexavalent chromium (Cr(VII) is a frequent pollutant in industrial wastewater that flows into wastewater treatment plants. Wastewaters containing high concentrations of Cr may inhibit or even stop the microbial activity during the treatment procedure. In her dissertation ***Dr. Breda Novotnik*** *(Supervisor Associate Professor Radmila Milačič) investigated the influence of different Cr(III) and Cr(VI) concentrations on activated sludge nitrification. The results of the investigation provide a new insight into the toxicity of Cr species with respect to activated sludge nitrification and the fate of the Cr(VI) in the sludge. This information is of importance for the management of wastewater treatment plants in order to protect them from inflows containing harmful Cr(VI) concentrations. She published five articles, including: Novotnik Breda, Zuliani Tea, Ščančar Janez, Milačič Radmila. Inhibition of the nitrification process in activated sludge by trivalent and hexavalent chromium, and partitioning of hexavalent chromium between sludge compartments. Chemosphere, 2014, 105, 87-94.*

Dr. Breda Novotnik has also investigated analytical aspects of chromium speciation. She has focused on the appropriate preparation of enriched stable isotopes of chromium species, since it is known that the inappropriate preparation of these compounds may lead to artefacts in chromium speciation. She has developed procedures based on the digestion of enriched isotopes of chromium trioxide. The $^{50}Cr(VI)$ was prepared by alkaline melting, where quantitative oxidation to Cr(VI) was achieved with oxygen from the air at alkaline pH without the use of aditional oxidizing agents. A microwave-assisted digestion was developed for the preparation of $^{53}Cr(III)$ without the use of reducing agents. The study showed the importance of the proper preparation of spike solutions that are to be used in environmental studies. Example: Novotnik Breda, Zuliani Tea, Martinčič Anže, Ščančar Janez, Milačič Radmila. Preparation of Cr(VI) and Cr(III) isotopic spike solutions from ^{50}Cr and ^{53}Cr enriched oxides without the use of oxidizing and/or reducing agents. Talanta, 2012, 99, 83-90.

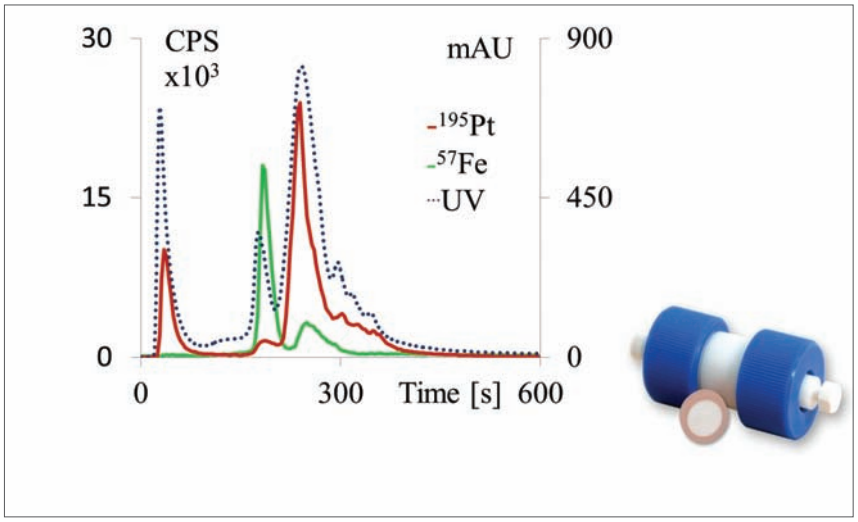


Priprava izotopsko obogatenih raztopin kroma iz kromovega trioksida

Preparation of Cr isotopic spike solutions from chromium trioxide

- **Speciacija kemoterapevtikov na osnovi kompleksov platine v humanem serumu**

Doktorand **Anže Martinčič** (mentor prof. dr. Janez Ščančar) je v disertaciji razvil inovativno metodo za ločbo ionskih oblik kemoterapevtikov in deleža, vezanega na serumske proteine. Metoda je zasnovana na kombinaciji dveh zaporedno vezanih monolitnih diskov: afinitetnega, ki specifično veže imunoglobilin G, in anionsko izmenjalnega diska CIM DEAE, na katerem se loči nevezana oblika kemoterapevtika od tistega vezanega na albumin in transferin. V kombinaciji z UV in masno spektrometričnim detektorjem (ICP-MS) je preučeval kinetiko vezave cisplatina, karboplatina in oksaliplatina na serumske proteine v vzorcih človeškega seruma. Razvita metoda CLC je bila prvič uporabljena na področju metalomike. Rezultati so opisani v članku Martinčič Anže, Čemažar Maja, Serša Gregor, Kovač Viljem, Milačič Radmila, Ščančar Janez. A novel method for speciation of Pt in human serum incubated with cisplatin, oxaliplatin and carboplatin by conjoint liquid chromatography on monolithic disks with UV and ICP-MS detection. *Talanta*, 2013, 116, 141-148. S sodelavci je objavil pet člankov.



Speciacija cisplatina v humanem serumu z monolitno kromatografijo CLC in ICP-MS detekcijo

Speciation of cisplatin in serum by monolithic CLC and ICP-MS detection

- **Speciacija aluminija v humanem serumu**

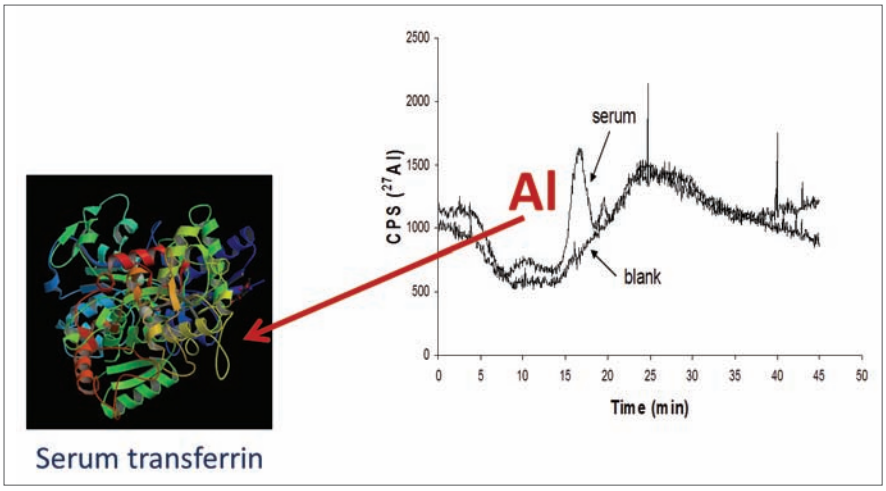
Dr. Simona Murko (mentor prof. dr. Janez Ščančar) je v disertaciji razvila novo analizno metodo za speciacijo aluminija (Al) v humanem serumu na fizioloških koncentracijskih nivojih. Al zvrsti je ločila na hitri monolitski koloni CIM DEAE in ločbi proteinov sledila z UV detekcijo. Ločene Al zvrsti je določila »on-line« z masno spektrometrijo z induktivno sklopljeno plazmo. Eksperimenti so pokazali, da se je okoli 90 % Al v serumu eluiralo pod kromatografskim vrhom transferina. To je bilo prvo poročanje o kvantitativnem določanju Al v humanem serumu na fizioloških koncentracijskih nivojih v svetovnem merilu, delo pa je bilo objavljeno v najuglednejši reviji na področju analizne kemije. Murko Simona, Milačič Radmila, Kralj Bogdan, Ščančar Janez. Convective interaction media monolithic chromatography with ICPMS and ultraperformance liquid chromatography-electrospray ionization MS detection: a powerful tool for speciation of aluminum in human serum at normal concentration levels. Analytical Chemistry, 2009, 81, 12, 4929-4936. Doktorandka je objavila osem člankov.

- ***Speciation of chemotherapeutics on the basis of platinum complexes in human serum***

In his dissertation ***Anže Martinčič*** *(Supervisor Associate Professor Janez Ščančar) developed an innovative method for the simultaneous, two-dimensional separation of ionic forms of platinum-based chemotherapeutics from the portions bound to different serum proteins. The method is based on conjoint liquid chromatography (CLC) in which CIM Protein G and CIM DEAE disks are assembled in a single housing, forming a CLC monolithic column. On the first disk the chemotherapeutic bound to immunoglobulin G is separated, while on the second disk the unbound form of the chemotherapeutic is separated from the portion bound to albumin and transferrin. In combination with UV and inductively coupled plasma mass spectrometry (ICP-MS) detection he investigated the kinetics of the binding of cisplatin, carboplatin and oxaliplatin to serum proteins in human serum. The developed CLC method was for the first time applied in the field of metallomics. The results are described in: Martinčič Anže, Čemažar Maja, Serša Gregor, Kovač Viljem, Milačič Radmila, Ščančar Janez. A novel method for speciation of Pt in human serum incubated with cisplatin, oxaliplatin and carboplatin by conjoint liquid chromatography on monolithic disks with UV and ICP-MS detection. Talanta, 2013, 116, 141-148. With coworkers he published five articles.*

- ***Speciation of aluminium in human serum***

In her dissertation ***Dr. Simona Murko*** *(Supervisor Associate Professor Janez Ščančar) developed a new analytical procedure for the speciation of aluminium (Al) in human serum at physiological concentration levels. The separation of proteins was performed on a fast CIM DEAE monolithic column and was followed by UV detection. The separated Al species were detected on-line by inductively coupled plasma mass spectrometry (ICP-MS). It was experimentally proven that about 90 % of the Al in human serum was eluted under the transferrin peak. This is a world-first report on a quantitative and reliable speciation of Al in human serum at physiological concentration levels. The work was published in the most renowned journal from the field of analytical chemistry. Murko Simona, Milačič Radmila, Kralj Bogdan, Ščančar Janez. Convective interaction media monolithic chromatography with ICPMS and ultraperformance liquid chromatography-electrospray ionization MS detection: a powerful tool for speciation of aluminum in human serum at normal concentration levels. Analytical Chemistry, 2009, 81, 12, 4929-4936. With co-workers, Dr. Simona Murko published eight articles.*

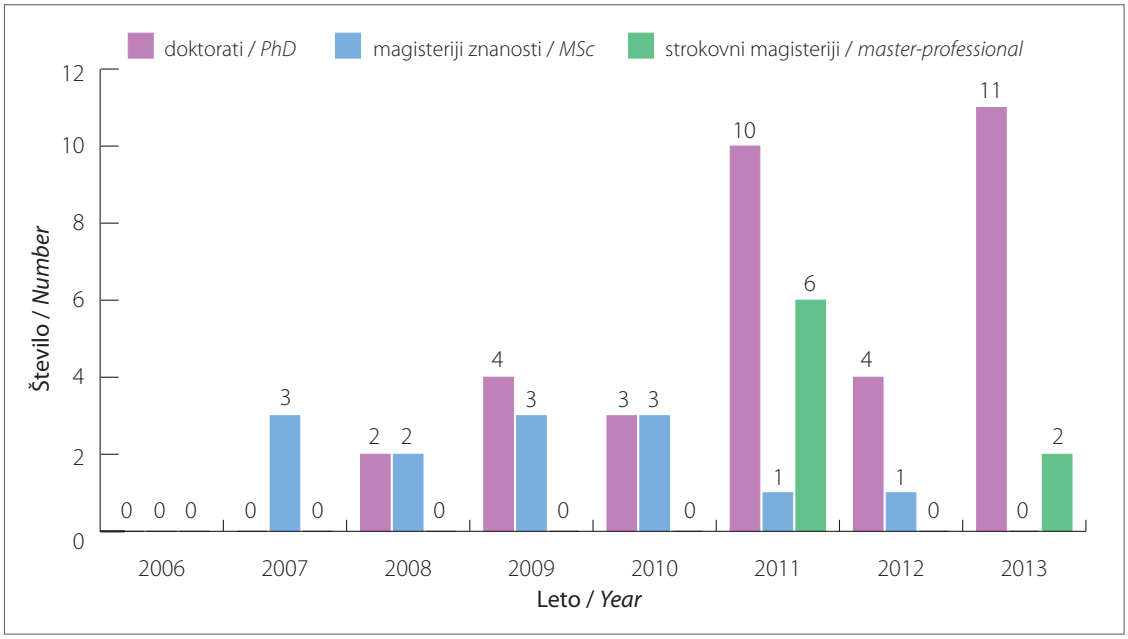


Kromatogram ločbe Al v humanem serumu z CIM-DEAE-ICP-MS. Kromatografski vrh predstavlja Al, vezan na transferin.

Chromatogram of Al separation in human serum by CIM-DEAE-ICP-MS. The chromatographic peak represents Al bound to transferrin.

DOKTORJI IN MAGISTRI EKOTEHNOLOGIJE

V prvih desetih letih delovanja MPŠ je na programu Ekotehnologija doktoriralo 34 in magistriralo 21 kandidatov. Od tega je študij končalo 13 kandidatov iz tujine.



Doktorati in magisteriji na MPŠ v prvem desetletju, skupaj 55
PhD and MSc at IPS in the first decade, total 55

Večina del je vezana na reševanje konkretnih problemov na naslednjih področjih:

- orodja za nadzor kakovosti okolja, ki vključujejo tudi integrirana modelna orodja za politično odločanje,
- razvoj in testiranje okoljsko sprejemljivih materialov
- razvoj in testiranje čistih tehnologij
- karakterizacija in predelava odpadkov in odpadnih voda
- gospodarjenje z vodami
- plazemske tehnologije
- razvoj inteligentnih sistemov za nadzor kakovosti okolja
- trajnostno gradbeništvo
- prehrana in okoljsko zdravstvene tehnologije

DOCTORS AND MASTERS OF ECOTECHNOLOGY

In the first ten years of the IPS, 34 doctors and 21 masters completed their studies under the Ecotechnology programme, of which 13 candidates came from abroad.

Most of the theses discuss the possibilities of solving real-life problems in the following fields:

- *tools for environmental quality control, which also involve the development of model tools for political decision-making*
- *development and testing of environmentally acceptable materials*
- *development and testing of clean technologies*
- *characterisation and recovery of waste and wastewater*
- *water management*
- *plasma technologies,*
- *development of intelligent systems for environmental quality control*
- *sustainable construction*
- *sustainable engineering*
- *food and environmental health technologies*

Velika predavalnica IJS

JSI Main lecture hall

KAJ PRAVIJO EKOTEHNOLOGI – ALUMNI MPŠ?

Mag. Jože Katanec
Oddelek za intelektualno lastnino
Gorenje gospodinjski aparati, Velenje

Za gospodinjske aparate že dolgo ne zadošča več, da so prijetni na pogled, zanesljivi in uporabni, biti morajo tudi prijazni do okolja. To velja za njihov celoten življenjski cikel: izdelavo, delovanje in razgradnjo na koncu življenjske dobe. Ob tem se pojavlja vedno več vprašanj in novih izzivov, posebej kateri novi materiali in tehnologije so boljši že sedaj ali pa bodo v bližnji prihodnosti? Poseben izziv so nanomateriali in nanotehnologije, zlasti kakšen je lahko njihov prispevek k trajnostnemu razvoju in s katerimi postopki lahko učinkovito merimo njihov vpliv na okolje?

Odgovore sem iskal in marsikaterega tudi našel med študijem na Mednarodni podiplomski šoli Jožefa Stefana, kjer sem v okviru magistrskega dela preučeval možnosti antibakterijskih zaščit površin, predvsem tistih, ki so primerne za gospodinjske hladilnike. Ugotavljal sem realne možnosti uporabe foto-katalitskih materialov na osnovi titanovega dioksida. Dokopal sem se do novih spoznanj, ki so uporabna za razvoj in proizvodnjo boljših izdelkov, obenem pa razvijal sposobnosti za širše pristope k trajnostnemu razvoju.

Hvaležen sem profesorjem v sklopu programa Ekotehnologija za ustvarjalen odnos, zelo zanimiv in uporaben študij ter še posebej za to, da imajo rezultati tudi uporabno vrednost pri mojem strokovnem delu. To podpira mojo željo dodajati drobne kamenčke v mozaik tehnološkega napredka za prijaznejši svet in pošten odnos človeka do sveta.

WHAT ECOTEHCHNOLOGISTS – IPS ALUMNI – HAVE TO SAY?

Jože Katanec, MSc
Department for Intellectual Property
Gorenje Home appliances, Velenje

For quite some time now, home appliances no longer need to be just pretty, reliable and useful – they also need to be environment friendly. This applies to their entire life cycle: production, operation and decomposition at the end of their life cycle. More and more questions and new challenges arise, especially in relation to which new materials and technologies are better now or will be in the near future. Nanomaterials and nanotechnologies are a special challenge; in particular we are interested in knowing what is their contribution to sustainable development and which procedures can be used to efficiently measure their impact on the environment?

I was looking for answers and found many during my studies at the Jožef Stefan International Postgraduate School, where I examined the possibilities for the antibacterial protection of surfaces, particularly those appropriate for refrigerators, in the framework of my master's thesis. I studied possibilities for the use of titanium dioxide-based photocatalytic materials. I recorded new findings that are useful for the development and production of better products, and at the same time I studied the possibilities for broader approaches to sustainable development.

I am grateful to the professors of the Ecotechnology programme for their creative approach, very interesting and useful studies and especially for enabling the application of the results to my professional work. This supports my desire to add small pieces into the mosaic of technological advances for a better world and a fair human attitude in relation to the world.

Dr. Tina Kosjek
Znanstvena sodelavka
Odsek za znanosti o okolju, Institut »Jožef Stefan«

Hitra rast svetovnega prebivalstva, podaljševanje življenjske dobe, napredek v diagnostiki bolezni in izboljšana zdravstvena oskrba so med drugim prispevali k skokovitemu porastu v porabi zdravil, s tem pa tudi k povečanju tveganja, ki ga prinašajo ostanki teh zdravil, potem ko preidejo v okolje. S to problematiko se poraja vrsta novih vprašanj. V kolikšni meri se ostanki zdravil pojavljajo v okolju? Ali dolgodobna izpostavljenost tem biološko aktivnim spojinam ogroža obstoj vodnih ekosistemov in posledično človeka? V kaj se ta zdravila razgradijo, ko so izpostavljena čiščenju odpadnih vod ali dejavnikom razgradnje v okolju? Ali so ti produkti razgradnje zdravil še bolj toksični vodnim organizmom kot same zdravilne učinkovine? Na kakšne načine lahko omejimo ali preprečimo vstopanje ostankov zdravil v okolje? Ob tem me je spremljala še ena ključna negotovost: Ali ostanki zdravil v okolju sploh predstavljajo problem ali smo si to »problematiko« omislili samo zato, ker skokovit napredek v analizni instrumentaciji danes omogoča take raziskave?

Ko sem začenjala s študijem na Mednarodni podiplomski šoli Jožefa Stefana, je bilo to področje tako rekoč popolnoma novo, nepreverjeno, neraziskano, kar ni dajalo zagotovila, da to lahko postane tema doktorskega dela. Kljub temu mi profesorji na šoli, vsi sicer zelo uspešni raziskovalci, nikoli niso vlivali dvomov. Nasprotno, vselej sem bila deležna vzpodbude in podpore, seveda pa je bil bistven tudi njihov idejni prispevek, vodenje in posluh za težave, ki so se porajale med mojimi raziskavami. To je bilo še zlasti pomembno in izrazito na začetku študija, ki sem ga vključila v naporen urnik ob redni zaposlitvi tedaj še na drugem koncu Slovenije. Zato sem se študiju lahko posvetila le ob najbolj nemogočih urah – podpora in posluh šole sta bila takrat najbolj ključna. Danes sem hvaležna tistim, zaradi katerih sem vztrajala, in zaradi negotovega začetka še toliko bolj vesela, da sem raziskave v okviru teme svojega doktorskega dela uspešno zaključila z doktoratom.

Dr. Tina Kosjek
Researcher
Department of Environmental Sciences, Jožef Stefan Institute

A rapid population growth, longer life spans, progress in the diagnosis of diseases and improved medical care, among other things, have contributed to the rapid growth of medication use and consequently an increased risk entailed by the pharmaceutical residues after their transfer to the environment. This issue raises many new questions. To what extent do pharmaceutical residues occur in the environment? Does a long-term exposure to these biologically active compounds threaten the existence of water ecosystems and consequently humans? What do these pharmaceuticals decompose into when they are exposed to wastewater treatment or decomposition factors in the environment? Are these decomposition products even more toxic to water organisms than the active substances themselves? What are the possibilities for restricting or preventing the entering of pharmaceutical residues into the environment? One key uncertainty accompanied me along the way: Are pharmaceutical residues even a real problem or was this problem created just because of the rapid progress in analytical instrumentation which enables such research?

While I was starting my studies at the Jožef Stefan International Postgraduate School, this scientific field was relatively new, unverified, unexplored and did not give any guarantee that this can become a topic of a doctoral dissertation. Nevertheless, the IPS professors, all acclaimed researchers, never expressed any doubt. On the contrary, they always offered me encouragement and support, while their ideas, supervision and help in solving problems during the period of my research were also of key importance. This was especially crucial at the beginning of my study when I had to find time in my busy schedule due to my employment on the other side of Slovenia. Consequently, I could devote myself to my studies only at the most unreasonable hours. Today, I am grateful to those who encouraged me and because of the uncertain beginnings I am even happier that I completed my research with a doctoral dissertation.

Dr. David Kocman
Znanstveni sodelavec
Odsek za znanosti o okolju, Institut »Jožef Stefan«

Živo srebro je že vrsto let prepoznano kot onesnažilo globalnega pomena. Vzrok tiči v kompleksnosti njegovih okoljskih pretvorb, načinih transporta ter predvsem sposobnosti kopičenja v prehranjevalnih verigah. V zadnjih letih je zmanjšana uporaba živega srebra v industrijskih procesih sicer privedla do zmanjšanih izpustov tega onesnažila v okolje. Problem, ki ostaja, pa so predvsem okolja, obremenjena zaradi pretekle uporabe oziroma dejavnosti. V Sloveniji se s tovrstnim problemom srečujemo na območju Idrije. Leto predstavlja ekosistem, ki je močno obremenjen z živim srebrom zaradi večstoletne rudniške dejavnosti.

V okviru doktorske naloge sem izdelal okoljski model glavnih virov in ponorov živega srebra na nivoju porečja Idrijce ter prehajanja le-tega med različnimi okoljskimi segmenti, kar je omogočilo prostorsko identifikacijo najbolj kritičnih današnjih žarišč na področju porečja. Sledenje snovnih tokov živega srebra na porečjih zajema terensko in laboratorijsko preučevanje kompleksnih prehodov živega srebra med kopenskimi ekosistemi in vodnim okoljem na eni strani ter izmenjavo z atmosfero na drugi.

Študij na Mednarodni podiplomski šoli Jožefa Stefana, skupaj z vso potrebno raziskovalno infrastrukturo na Odseku za znanosti o okolju Instituta »Jožef Stefan«, v okviru študijskega programa Ekotehnologija mi je omogočil pridobiti potrebna znanja za učinkovito sledenje in modeliranje tovrstnih procesov. Za to se najlepše zahvaljujem profesorjem na šoli in sodelavcem na odseku. Predvsem me veseli dejstvo, da so se v okviru naloge izdelani pristopi izkazali za uporabne, npr. pri oblikovanju strokovnih podlag, na katerih med drugim temelji Konvencija Minamata o živem srebru, mednarodna zaveza o izpustih živega srebra na globalnem nivoju.

Dr. David Kocman
Researcher
Department of Environmental Sciences, Jožef Stefan Institute

Mercury has long been known as a pollutant on a global scale. The reason behind this is in the complexity of its environmental transformations, the means of transport and especially its accumulative potential in food chains. In the past few years, the decreased use of mercury in industrial processes has also led to a reduced emission of this pollutant into the environment. However, environments that are burdened by past use or activity remain problematic. In Slovenia, this is especially the case in the Idrija area, due to an ecosystem that is heavily burdened by mercury due to several hundred years of mercury mining.

In the framework of my doctoral dissertation I designed an environmental model of the main sources and sinks of mercury in the Idrijca River catchment, as well as the uptake of mercury between different environment segments, which enabled the identification of the most critical points in the catchment area today. The tracing of mercury material flows in the catchments entails field and laboratory research of complex uptakes of mercury between inland ecosystems and the aquatic environment, on the one hand, and the transfer into the atmosphere, on the other.

The studies at the Jožef Stefan International Postgraduate School, together with all the necessary research infrastructure at the Jožef Stefan Institute's Department of Environmental Sciences, in the framework of the Ecotechnology study programme enabled me to acquire the necessary knowledge for efficient tracing and modelling of such processes. I am extremely thankful to the IPS professors and colleagues at the department. I am especially delighted by the fact that the approaches which were designed in the framework of my doctoral dissertation turned out to be useful, for example, in designing professional platforms that serve as a foundation for the Minamata convention on mercury, an international treaty on mercury emissions on a global scale.

Dr. Tanja Ljubič Mlakar
Vodja ekologije ter varstva in zdravja pri delu
Salonit, Anhovo

Za podjetja je bistvenega pomena skrb za okolje ter vgrajevanje novih spoznanj na področju varstva okolja v proizvode in tehnologije. To je še posebej pomembno za energetsko in snovno intenzivno procesno industrijo, v kateri je potrebno poznati procese nastanka emisij in prenašanja onesnaževal v okolje ter razviti tehnike merjenja in zmanjševanja emisij. Zanimiva so zlasti tista onesnaževala, ki lahko na okolje in zdravje vplivajo že v zelo majhnih koncentracijah. Tovrstne raziskave s svojo visoko strokovnostjo in možnostmi mednarodnega povezovanja omogoča študij Ekotehnologije na Mednarodni podiplomski šoli Jožefa Stefana.

Doktorska študija živega srebra v procesu proizvodnje cementnega klinkerja je prispevala k boljšemu razumevanju procesov kroženja živega srebra, njegovih oblik, masnih tokov in masnih bilanc v procesu. Raziskovani so bili vhodni, izhodni in vmesni materiali v procesu ter različne zvrsti živega srebra v dimnih plinih. Podane so bile osnove za nadzor emisij ter možnosti učinkovitega odstranjevanja živega srebra iz procesa. Ob vse večji uporabi sekundarnih surovin in goriv je vidik poznavanja teh procesov zelo pomemben za njihovo nadzorovano uporabo.

Študija je proučevala tudi kontaminacijo z živim srebrom v okolici cementarne z uporabo metod biomonitoringa z lišaji. Ugotovljene so bile pomembne korelacije med vsebnostjo živega srebra v indikatorskih rastlinah in emisijami živega srebra iz cementarne, kar potrjuje, da so stroškovno ugodne metode biomonitoringa lahko učinkovita dopolnilna orodja za spremljanje živega srebra v okolju. Glede na razvoj zakonodaje, partnerskega programa UNEP in globalnih strategij bo ta vidik v bodoče postal še aktualnejši.

Dr. Tanja Ljubič Mlakar
Head of Ecotechnology, safety and health at work
Salonit, Anhovo

Environmental care and implementing new findings in the field of environment protection for products and technologies are of key importance for companies. This is especially the case for the energy- and materials-intensive process industry, where we need to know the processes responsible for emissions and the transmission of pollutants to the environment, as well as develop the techniques for measuring and reducing emissions. Pollutants that can influence the environment in very small quantities are particularly interesting. The Ecotechnology programme of the Jožef Stefan International Postgraduate School enables such research, with its professional competence and possibilities for international cooperation.

In the doctoral dissertation we did research on mercury in the process of cement clinker production and the results contributed to a better understanding of the processes of mercury circulation, its forms, material flows and mass balance in the process. We researched starting and final materials, and intermediates in the process, as well as various types of mercury in flue gases. We discussed the foundations for controlling the emissions and the possibilities for an efficient removal of mercury from the process. With an increased use of secondary raw materials and fuels, knowledge of these processes is very important for their controlled use.

The research also studied mercury contamination around the cement factory by using the lichen biomonitoring methods. Important correlations between the mercury level in indicator plants and the mercury emissions from the cement factory were established, which confirms that cost-effective biomonitoring methods can be efficient supplementary tools for monitoring mercury in the environment. This will become even more current in the future, when considering the development of the legislation, UNEP partner programme and global strategies.

Obisk predstavnikov kitajskega Ministrstva za okolje v Salonitu v okviru akcij za obvladovanje emisij živega srebra iz tega industrijskega sektorja

Visit from the representatives of China's Environment Ministry to Salonit in the framework of the initiatives for mercury-emissions control from this industry sector

Študentski svet MPŠ

Nejc Trdin

Predsednik Študentskega sveta MPŠ

President of the IPS Student Council

Študentski svet ima položaj organa Mednarodne podiplomske šole Jožefa Stefana (MPŠ) določen v Statutu MPŠ, zato sodeluje in enakopravno soodloča na Senatu, Akademskem zboru in Upravnem odboru MPŠ. Študentski svet ima dolžnost in pravico podajati mnenja in soodločati v vseh zadevah, ki se nanašajo na pravice in dolžnosti študentov.

Študentski svet sestavljajo vsi študenti šole, ki iz svojih vrst izvolijo svoje predstavnike – predsednika in tri podpredsednike, po enega na študijski program. To predsedstvo obravnava predloge študentov in drugih organov MPŠ ter oblikuje osnutke stališč in sklepov, ki jih posreduje v presojo celotnemu Študentskemu svetu ter po obravnavi pristojnim organom šole v odločanje.

Posebna naloga Študentskega sveta je skrb za neposredno vključevanje vsakega študenta v ustvarjalno življenje na šoli. Predstavniki Študentskega sveta so zato vedno na voljo vsem študentom, kadar potrebujejo pomoč šole pri uresničevanju svojih idej in želja ter pri reševanju svojih potreb in problemov. Predsedstvo Študentskega sveta neposredno sodeluje z vodstvom šole pri iskanju rešitev in zagotavljanju podpore.

Druga pomembna naloga je ustvarjanje sproščenega vzdušja na šoli. V to sodi tudi organizacija družabnih dogodkov, na katerih se utrjujejo obstoječe vezi med študenti različnih smeri in spodbujajo nove. V vsakem semestru študijskega leta je vsaj en tak dogodek, na katerega so povabljeni študenti in profesorji ter še posebej vodstvo šole. V sproščenem ozračju se gradijo bolj osebni odnosi, ki potem tudi v študijskem in raziskovalnem delu na šoli sproščajo še več ustvarjalnosti.

IPS Student Council

The Student Council is a statutory body of the Jožef Stefan International Postgraduate School and therefore participates and co-decides on an equal-rights basis at the meetings of the IPS Senate, the Academic Council and the Governing Board. The Student Council has the right and the obligation to provide an opinion and co-decide on all matters related to the rights and obligations of the students at the IPS.

The Student Council consists of all the IPS students who appoint their representatives – President and three Vice-Presidents, one for each study programme. The governing body discusses the propositions made by the students and the other IPS bodies and prepares opinions and decision drafts, which are then considered by the entire Student Council and subsequently passed on to other competent bodies for consideration.

The Student Council has a specific task, which is to directly involve each and every student in the creative life of the school. The representatives of the Student Council are therefore available at all times for all the students, whether they need help from the school in realising their ideas and desires or coping with their own needs and problems. The governing body of the Student Council directly collaborates with the management of the school in seeking solutions and providing support.

Another important task of the Student Council is creating a relaxed atmosphere at the school. This also means organising social events, where the existing links between the students from the different programmes are strengthened and new links are established. Each semester sees at least one such activity, to which students, professors and especially the management of the school are all invited. A relaxed atmosphere is a great platform for building closer personal relations, which then also stimulate creativity in the academic and research spheres.

Najprepoznavnejši dogodek Študentskega sveta je redna letna Študentska konferenca Mednarodne podiplomske šole Jožefa Stefana, na kateri študentom naše šole in tudi študentom drugih fakultet nudimo možnost promocije njihovega raziskovalnega dela. Študenti so že na začetku študijskega leta povabljeni, da za konferenco v maju pripravijo predstavitev svojih najboljših raziskovalnih dosežkov v obliki konferenčnega prispevka in plakata. Kakovost predloženih prispevkov zagotavlja recenzija, ki jo opravijo mentorji – uveljavljeni raziskovalci na posameznem področju. S tem zagotovimo študentom povratno informacijo izkušenih znanstvenikov o njihovem delu kot tudi pogoje za višjo kakovost prispevkov.

V želji po zbližanju znanstvene sfere in gospodarstva so na Študentsko konferenco povabljeni tudi ključni nosilci razvoja vodilnih slovenskih podjetij. Ti ocenjujejo raziskovalne dosežke študentov ter podajo informacije o razvojnih usmeritvah in ciljih svojih podjetij. V takšnem sodelovanju se presojajo pomen in možnosti znanstvenih dosežkov naših študentov za neposredno uporabo v praksi, zlasti v visokotehnoloških podjetjih.

Objavljanje raziskovalnih dosežkov v domačih in zlasti mednarodnih strokovnih revijah in druge medijske objave prispevajo k prepoznavnosti naše podiplomske šole v Sloveniji, Evropski uniji in tudi v svetovnem okviru. Študenti MPŠ sodelujejo v poljudnem tisku in v radijskih oddajah. Za prepoznavnost svojih dosežkov vzdržujejo predstavitveno spletno stran šole, spletno stran konference in e-poštni seznam študentov, kjer objavljajo novice, ki se tičejo študija in študentov naše šole.

Študentske konference MPŠ

V sklopu Študentske konference vsako leto izideta tudi dva zbornika: prvi vsebuje konferenčne prispevke v obliki člankov, drugi pa pripadajoče plakate. Oba vsebujeta skrbno izbrano besedilo, ki je namenjeno zainteresiranim na vseh področjih, zato je napisano v široko razumljivem jeziku. To je obenem tudi prispevek študentov MPŠ k uveljavljanju kulturne razsežnosti znanosti

Na koncu vsake Študentske konference MPŠ poleg nagrad za vsako izmed treh področij podelimo tudi glavno nagrado Študentske konference. Na naslednjih straneh so prikazani plakati prispevkov, ki so prejeli glavno nagrado Študentske konference v letih 2010, 2011, 2012 in 2013.

The most prominent event of the Student Council is the annual IPS Students' Conference, where our students and the students from other faculties are given the opportunity to promote their research work. At the beginning of the academic year, the students are invited to prepare a presentation of their best research achievements for the conference in May in the form of a conference paper or a poster. The quality of the papers is assessed by the review committee, made up of leading researchers from specific fields. This ensures that the students receive feedback on their work from experienced scientists and we also set the conditions for a higher quality of the papers.

With the aim of bringing together the scientific and economic sectors, the school also invites key research experts from leading Slovenian companies to take part in the Students' Conference. The experts assess the research achievements of the students and give information about the development programmes and the objectives of their companies. Promoting this type of collaboration, we try to estimate the significance and the possibilities of the scientific achievements of our students for direct application in practice, especially in high-technology companies.

By publishing our research achievements in both Slovenian and international scientific journals as well as in other media, the students aim to promote our postgraduate school in Slovenia, the European Union and worldwide. The IPS students also participate in the popular press and in radio programmes. We also maintain the IPS website, the Students' Conference homepage and the student mailing list, where we post all the latest news regarding studies at the IPS and its students.

IPS Students' Conference

Each year, two Proceedings of the Students' Conference are published: the first one contains conference papers in the form of articles, while the second one contains the related posters. Both also contain text that is written in a comprehensible manner that makes it understandable to the entire educated population. In this way, the students aim to contribute to the implementation of the cultural dimension of science.

At the end of each IPS Students' Conference we give awards for each of the three areas and also the grand award of the Students' Conference. On the following pages the posters of contributions, which have received the main award of the Students' Conference in the years 2010, 2011, 2012 and 2013, are displayed.

Kostanjev piknik
Chestnut picnic

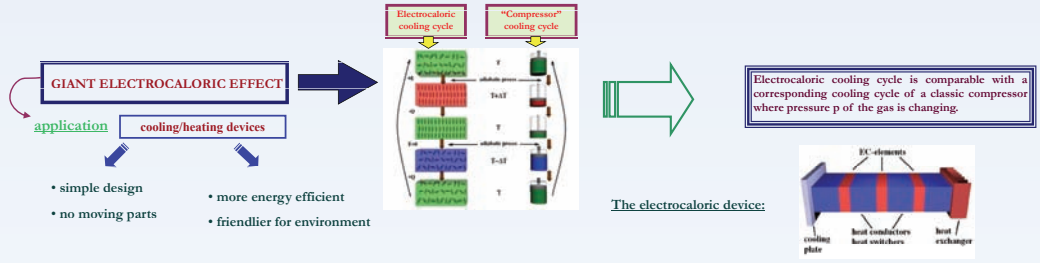
MEDNARODNA PODIPLOMSKA ŠOLA JOŽEFA STEFANA
JOŽEF STEFAN INTERNATIONAL POSTGRADUATE SCHOOL

THE GIANT ELECTROCALORIC EFFECT: phenomenon for application in cooling and heating devices of new generation

Brigita Rožič, prof. mat.
Jožef Stefan International Postgraduate School, Nanosciences and Nanotechnologies
MENTOR: prof. dr. Zdravko Kutnjak
CO-AUTHORS: dr. Barbara Malič, dr. Hana Uršič, dr. Janez Holc, dr. Marija Kosec, dr. Raša Pirc, dr. Robert Blinc
Jožef Stefan Institute, Jamova cesta 39, 1000 Ljubljana, Slovenia

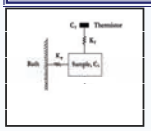
Abstract

Electrocaloric effect (ECE) is a change in the temperature of material due to electric field under adiabatic conditions, and it generates great interest due to its application, for example in electrical refrigeration. A giant electrocaloric effect was observed in inorganic ferroelectrics [1]. These observations were based on the indirect measurements of the electrical polarization. We show direct measurements of ECE in PMN, PMN-30 PT, PMN-35 PT and in PLZT 8/65/35 ceramics. Both bulk samples and thin films were measured. The temperature dependence reveals that the maximum of ECE is obtained at the ferroelectric phase transition. The magnitude of ECE shows that the giant ECE can be easily found in different classes of relaxor ferroelectrics.



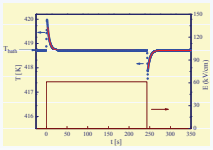
Exprimental method

Direct electrocaloric measurements via high resolution calorimeter



A simple diagram of the system of sample and calorimeter. A sample is coupled to a bath and thermistor by the thermal conductances.

Measurement:



- step electrical signal used
- ΔT calculated from fits to the exponentially decaying wings
- resistive heating also taken into account

SAMPLES

Produced by J. Holc, H. Uršič, M. Kosec, JSI

Produced by B. Malič, M. Kosec, JSI

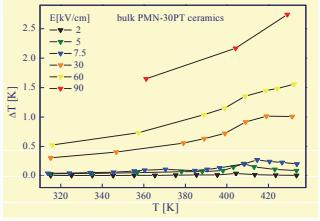
Produced by J. Holc, M. Kosec, JSI

Direct measurements of the giant electrocaloric effect

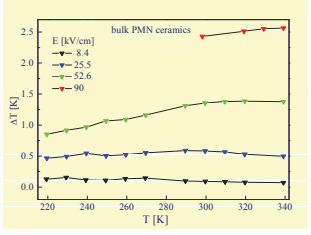
THICK FILMS

THIN FILMS

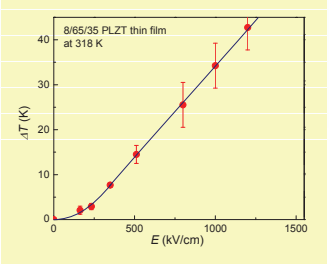
bulk PMN-30PT ceramics



bulk PMN ceramics

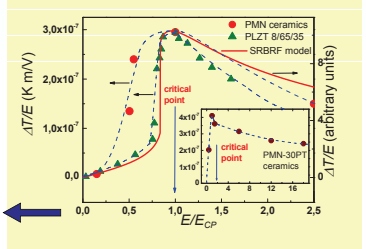


thin films of PLZT ceramics



Conclusion

We can conclude that direct measurements confirm existence of the giant electrocaloric effect in different classes of relaxor ferroelectrics. The largest electrocaloric effect is observable in thin PLZT films.



ΔT/E as a function of the maximum of the amplitude of the electric-field pulses (in units of *Ecp*) in bulk PMN, 8/65/35 PLZT and PMN-30PT ceramics (inset with same axis labels). Solid red line represents results of calculations of *ΔT/E* based on on a SRBRF model [2].

References

[1] A.S. Mischenko, Q. Zhang, J.F. Scott, R.W. Whatmore, N.D. Mathur, Science 311, 1270 (2006).
[2] B. Rožič, Sheng-Guo Lu, Z. Kutnjak, B. Malič, H. Uršič, J. Holc, M. Kosec, R. Pirc, R. Blinc, B. Neese, M. Lin, E. Furman, Q. M. Zhang (poslano v objavo, 2010)

MEDNARODNA PODIPLOMSKA ŠOLA JOŽEFA STEFANA
JOŽEF STEFAN INTERNATIONAL POSTGRADUATE SCHOOL

Določanje vsebnosti steroidnih estrogenov v odpadnih vodah brez predhodne ekstrakcije vzorcev

Miha Avberšek[1], Bojana Žegura[2], Metka Filipič[2], Ester Heath[1] (mentor)

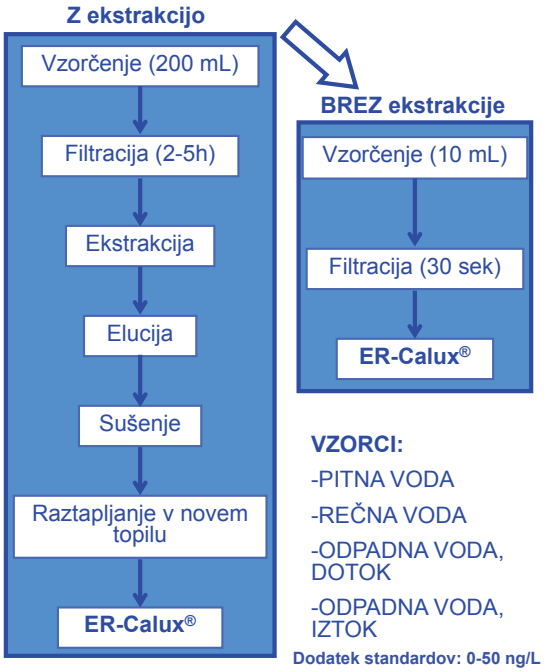
[1]Institut Jožef Stefan; Mednarodna podiplomska šola Jožefa Stefana; Smer: Ekotehnologija; miha.avbersek@ijs.si

[2]Nacionalni inštitut za biologijo

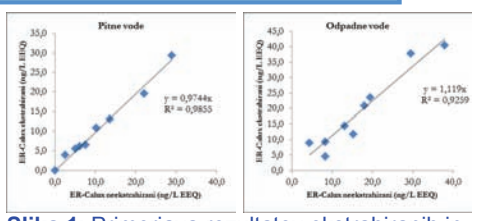
UVOD

Steroidni estrogeni (estron (E1), 17β-estradiol (E2), estriol (E3) in 17α-etinilestradiol (EE2)) so organska onesnažila, ki so pogosto prisotna v odpadnih vodah komunalnih čistilnih naprav in vodnem ekosistemu, kamor se te vode stekajo. So večinoma naravnega izvora in lahko negativno vplivajo na organizme v okolju. Prisotnost steroidnih estrogenov so dokazali že v mnogih študijah. Zaradi nizkih koncentracij (ng/L) so za določanje njihove prisotnosti potrebne občutljive kemijske in biološke metode. Tako kemijske kot tudi biološke metode zahtevajo dolgotrajno pripravo in predhodno ekstrakcijo vzorca. Cilj raziskave je bil, da z uporabo in prilagoditvijo ER-Calux® testa razvijemo postopek, ki bi omogočal testiranje okoljskih vzorcev, predvsem odpadnih vod, brez predhodne ekstrakcije spojin. Metodo smo optimizirali in uporabili na realnih vzorcih.

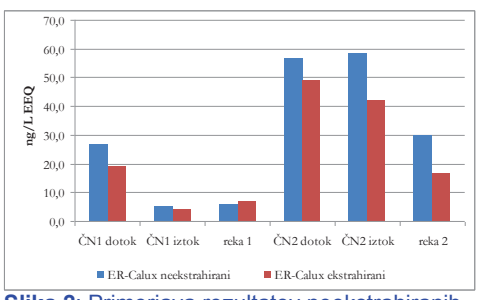
Metode in materiali



Rezultati



Slika 1: Primerjava rezultatov ekstrahiranih in neekstrahiranih vzorcev pitne in odpadne vode z dodanimi standardi



Slika 2: Primerjava rezultatov neekstrahiranih in ekstrahiranih vzorcev dotokov in iztokov iz dveh komunalnih čistilnih naprav ter rek, v katere se iztoka izlivata.

UPORABNOST V PRAKSI

Hitro in učinkovito zaznavanje prisotnosti steroidnih estrogenov je ključno pri oceni tveganja, ki ga povzroča prisotnost teh spojin v okoljskih vzorcih. V okviru naše raziskave smo razvili postopek, s katerim lahko estrogenost vzorcev določamo brez predhodne ekstrakcije in se tako izognemo zamudni pripravi vzorcev. Rezultati testiranja vzorcev brez predhodne ekstrakcije so primerljivi z običajno metodo, kjer je potrebno vzorce predhodno ekstrahirati. Prednost in uporabnost postopka je predvsem v tem, da hitreje pridemo do želenih rezultatov, kar omogoča hitre presejalne teste in izvajanje nadzornih meritev ter istočasno prihrani tudi material.

MEDNARODNA PODIPLOMSKA ŠOLA JOŽEFA STEFANA

JOŽEF STEFAN INTERNATIONAL POSTGRADUATE SCHOOL

BASIC STUDY OF RELAXORS: MATERIALS FOR HIGH TECHNOLOGICAL DEVICES

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Jožef Stefan International Postgraduate School
Programme of Study: Nanoscience and nanotechnologies,
SUPERVISOR: prof. dr. Zdravko Kutnjak
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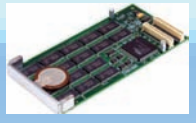
Abstract

Relaxor ferroelectric materials represent a subgroup of ferroelectrics and are charcterized by extraordinery properties which are useful for various applications in high technological devices. Relaxors exhibit high permittivity, ferroelectric hysteresis, high piezoelectric effects, high pyroelectric coefficients, strong electro-optic effects and anomalous temperature coefficients of resistivity.

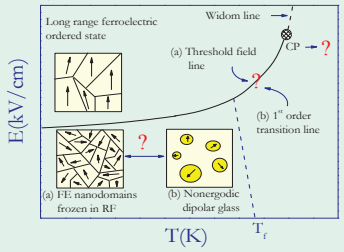




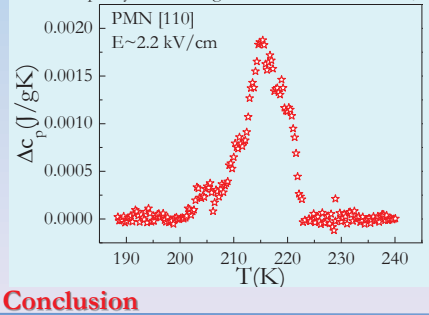


Our work is dedicated to understanding of ordering processes in these materials which is of a fundamental need for further application progress. Here, we address a long standing question about the nature of relaxor ground state in zero electric field. Over the years two possible relaxor ground state were presented as shown in electric field temperature diagram.

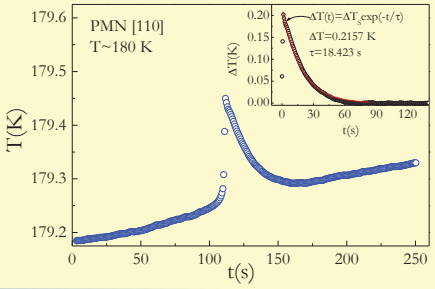
The nature of relaxors ground state is a matter of discussion since they were discover in 1959.



The isofield measurement obtained in ac mode show an excess of heat capacity in fields higher as critical electric field, E_C.



Anomaly of sample temperature observed in isothermal relaxation measurements is a consequence of the released latent heat at the ferroelectric transition.



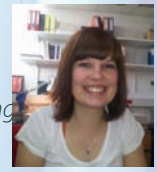
Conclusion

[1] The ac and relaxation calorimetric measurements show an excess of the heat capacity as well as sharp increase of the sample temperature as a consequence of the released latent heat at the electric field induced ferroelectric transition.

[2] The detected excess heat capacity and latent heat confirm the existence of true thermodynamic first order phase transition in ferroelectric relaxor PMN [110] single crystal.

[3] Our findings firmly support the physical picture of dipolar glass like relaxor ground state for PMN relaxor.

Stability of mercury compounds at high temperatures



Matej Sedlar, Majda Pavlin, Sani Bašič, Milena Horvat
Study programme: Ecotechnology
Supervision: prof. dr. Milena Horvat
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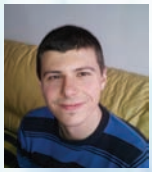


INTRODUCTION

What is the temperature fractionation of different mercury species applicable for?

- **to determine the release temperatures of different mercury compounds in solid samples (e.g. coal),**
- **to develop more efficient mercury removal technologies at high temperatures,**
- **to understand the complexity of mercury reactions in cement-producing industry.**

For developing the method of temperature fractionation, a home-made apparatus was used, in which known mercury compounds, pure or mixed with SiO_2, were heated by a slow increase of temperature (approximately 2.2 °C min^{-1}) to 800 °C in a flow of either nitrogen or air. Released elemental mercury was detected by an atomic absorption spectrometry technique. The results showed that not only the type of carrier gas, but also the substrate affected the number and size of the peaks and the temperature at which elemental mercury was released.

Method – Pyrolytic technique:

- Measuring apparatus: Lumex Pyro RA-915+ detection by cold vapour atomic absorption spectrometer (CVAAS) with Zeeman background correction,
- Temperature range: From room temperature to 800 °C,
- Heating rate: ~ 2.2 °C min^{-1},
- Carrier gas: Nitrogen or Air,
- Gas flow rate: 1 L min^{-1},

Sample:

- 9 mercury substances were used (**Hg_2Cl_2, $HgCl_2$, HgS, Hg_2SO_4, $HgSO_4$, HgF_2, HgSe, HgO-red and HgO-yellow**),
- Pure compounds,
- Compounds mixed with SiO_2 powder,
- Sample mass: 9 – 30 mg.

Fig. 1: HgS, pure and mixed with substrate in nitrogen

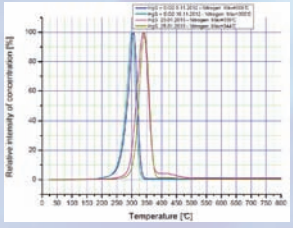
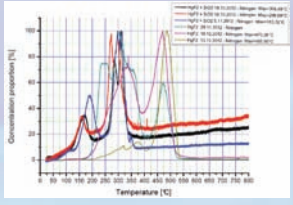
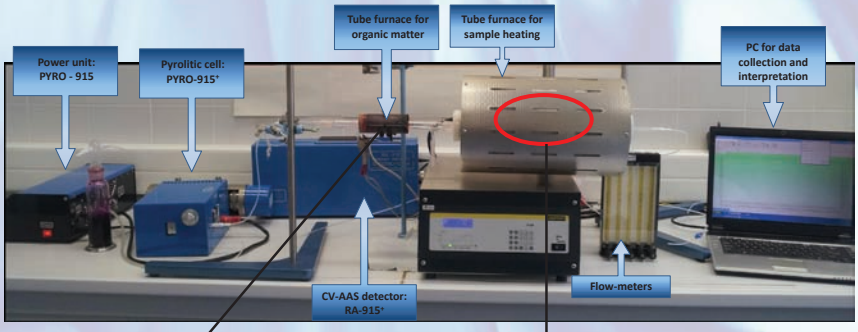
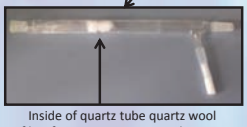


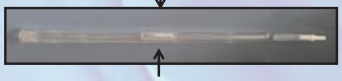
Fig. 2: HgF_2 pure and mixed with substrate in nitrogen







Inside of quartz tube quartz wool filter for organic matter can be seen



Inside of quartz tube quartz boat with sample can be seen

Fig. 4: HgSe pure and mixed with substrate in air

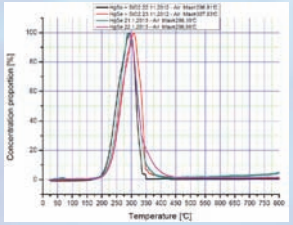
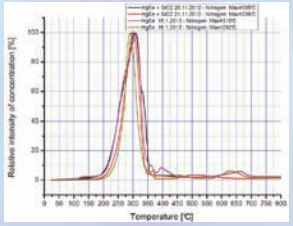


Fig. 3: HgSe pure and mixed with substrate in nitrogen



Results:

- Thermograms with one peak: HgS, Hg_2Cl_2, $HgCl_2$, HgO-red and HgO-yellow (Fig. 1),
- Thermograms with multiple peaks: HgF_2, Hg_2SO_4 and $HgSO_4$(Fig. 2),
- Thermogram of $HgSO_4$ is a single peak compound when used as a pure substance, but shows multiple peaks, when it is mixed with substrate SiO_2,
- Carrier gas effects the number of peaks and the temperature at which maximums occur,
- Substrate effects the mercury release for all compounds except for HgSe (Fig. 3, 4),
- The achieved repeatability of the maximum peak is below 15 degrees range.

Future work:

- Other substrates will be used such as: $CaSO_4$, Al_2O_3, charcoal and coal.
- Other pure mercury compounds as well as mixtures of them will be examined.

References:

- H. Biester and C. Scholz. Determination of Mercury Binding Forms in Contaminated Soils: Mercury Pyrolysis versus Sequential Extractions. Environ. Sci. Technol., 31:233–239, 1997,
- G. Luo, et al.. Identifying modes of occurrence of mercury in coal by temperature programmed pyrolysis. Proceedings of the Combustion Institute, 33:2763–2769, 2011,
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Kakovost: navzgor ni meje!

Če bi morala Mednarodna podiplomska šola Jožefa Stefana (MPŠ) opredeliti en sam cilj svojega dela, bi bila to vrhunska kakovost.

Napori za nenehno višanje kakovosti so neogibna zahteva zlasti na področjih, kot so:

- opredelitev poslanstva šole,
- umestitev šole v okolje,
- usmerjanje kandidatov v študij na MPŠ,
- zasnova študijskih programov,
- izbira učiteljev, mentorjev in somentorjev,
- zagotavljanje vrhunske raziskovalne opreme,
- pridobivanje mednarodnih izkušenj,
- objavljanje raziskovalnih dosežkov,
- gojenje znanstvene kulture.

Poslanstvo MPŠ

Poslanstvo MPŠ je z raziskovalno-izobraževalnim pristopom visoke kakovosti prispevati k ustvarjanju znanja in materialnih ter kulturnih dobrin. Ustvarjanje znanja se dosega z raziskovanjem, ustvarjanje materialnih in kulturnih dobrin pa s prenosom tega znanja v procese dela in odločanja. MPŠ zato na vseh področjih uveljavlja visoke kriterije tako za kakovost raziskovalnega dela kot za prenos dosežkov skozi znanstvene in druge medije v svetovno zakladnico znanja. Vse bolj pa se tudi MPŠ zaveda nuje trajnostnega gospodarskega in socialnega razvoja, še posebej v okolju svojega delovanja. Zato v vseh svojih dejavnostih podpira uveljavljanje znanstvenih dosežkov kot ključnega pogoja za razvoj visokih tehnologij, odpiranje visoko ustvarjalnih zaposlitvenih možnosti ter ustvarjanje dodane vrednosti, ki je neogibni materialni pogoj za družbo.

Umestitev MPŠ v okolje

Izhodišče za umestitev šole v njeno okolje je spoznanje, da je prvi pogoj za doseganje vrhunske kakovosti najprej do skrajnosti izkoristiti že doseženo. Za podiplomski študij so ključne raziskovalne kapacitete – raziskovalci in oprema – ter možnosti hitrega prilagajanja programov napredku znanosti in tehnologij, še posebej pri ciljanju k potrebam gospodarskega in socialnega napredka. Raziskovalne kapacitete so za MPŠ zagotovljene na najvišji ravni – in obenem z najnižjimi možnimi dodatnimi stroški – v okviru ustanovitelja Instituta "Jožef Stefan" (IJS) in sodelujočih institucij: Nacionalnega instituta za biologijo (NIB) ter Instituta za kovinske materiale in tehnologije (IMT). Sodelovanje gospodarskih soustanoviteljev in številnih pridruženih partnerjev iz industrije pa ima bistveno vlogo pri določanju specifičnih usmeritev in zagotavljanju kakovosti ciljanja študijskih programov MPŠ.

Quality: no Limits Ahead

If the Jožef Stefan International Postgraduate School (IPS) had to define a single objective, it would be quality.

Efforts at a constant improvement in quality are an inevitable requirement, especially in the following fields:

- *defining the mission of the school,*
- *placing the IPS in the environment,*
- *motivating candidates to study at the IPS,*
- *designing study programmes,*
- *selecting professors, supervisors and co-supervisors,*
- *ensuring high-quality research equipment,*
- *acquiring international experience,*
- *publishing research achievements,*
- *developing the culture of science.*

IPS mission

The mission of the IPS is to contribute to creating knowledge as well as material and cultural wealth by a research and education approach of high quality. Creating knowledge is achieved by research, while creating material and cultural wealth is through applying the acquired knowledge to work processes and decision-making. Therefore, the IPS is establishing high criteria in all fields for the quality of its research work as well as the transfer of the achievements through science and other media into the world's treasury of knowledge. The IPS is becoming more and more aware of the importance of sustainable economic and social development, especially in the environment of its operation. In all its activities, the school supports the implementation of research achievements as a crucial requirement for the development of high technologies, opening up extremely creative employment possibilities and creating added value, which is an important material requirement for society.

Placing the IPS in the environment

The basis for placing the school in its environment is realising that in order to reach the highest quality, we must first exploit as best we can what has already been achieved. Research capacities – researchers and equipment – and the ability to make rapid adjustments to the programmes for the progress of knowledge and technologies are of key importance for postgraduate studies, especially when aiming for economic and social progress. The research capacities of the IPS are secured at the highest level – and with the lowest possible additional expenses – in the framework of the IPS founder – the Jožef Stefan Institute (JSI) – and other collaborating institutions: the National Institute of Biology (NIB) and the Institute of Metals and Technology (IMT). The collaboration with the economic cofounders and numerous associate partners from industry has a crucial role in designing the specific directions and ensuring the quality of the IPS study programmes.

Usmerjanje kandidatov v študij na MPŠ

Informiranje zainteresiranih za študij na MPŠ poteka prek odgovornih vladnih institucij, sredstev obveščanja (spletna stran MPŠ, objave v časopisih, na radiu in TV), z vabili na odprte dneve IJS in MPŠ, prek raziskovalnih in industrijskih partnerjev MPŠ, najbolj učinkoviti pa so osebni stiki med potencialnimi kandidati in študenti ter učitelji MPŠ. Vpis na doktorski študij je omejen na praviloma 55 študijskih mest. MPŠ sprejema predvsem študente z visokimi dosežki dodiplomskega študija – povprečje tega za vse študente ob prvem vpisu na MPŠ je nad 8,5 (npr. za doktorski študij v šolskem letu 2012/2013 je bil 8,64, v šolskem letu 2013/2014 pa 8,73). Vendar dosežki dodiplomskega študija niso edino merilo. S kandidati za vpis potekajo načrtni intervjuji, v katerih se ugotavljata zlasti njihova ustvarjalna naravnanost in talent za raziskovanje. Pomembno vlogo pri tem imajo njihovi potencialni zaposlovalci, zlasti na raziskovalnem in gospodarskem področju. Dobra četrtina študentov MPŠ prihaja iz drugih držav, doslej največ iz Evrope (Albanija, Belorusija, Bosna in Hercegovina, Črna Gora, Finska, Hrvaška, Italija, Kosovo, Makedonija, Poljska, Portugalska, Romunija, Rusija, Srbija, Španija in Ukrajina), Azije (Indija, Pakistan, Širilanka in Uzbekistan) ter tudi iz Mehike in Brazilije, s katero potekajo dogovori o tesnejšem sodelovanju

Zasnova študijskih programov

MPŠ snuje svoje študijske programe na interdisciplinarnih in multidisciplinarnih področjih in pri tem daje prednost visokim tehnologijam. Povezovanje posameznih disciplin v okviru programov poteka po dveh kriterijih kakovosti: znanstveni kriterij terja visoko razvita in hitro napredujoča teoretska znanja, razvojni kriterij pa njihov pomen za napredek tehnologij ob upoštevanju možnosti za prenos znanja v razvojne napore gospodarstva in socialnega sektorja. Pri tem MPŠ upošteva tako tekoče potrebe kot dolgoročnejše usmerjanje v trajnostni razvoj.

Trem študijskim programom, ki se izvajajo na MPŠ od ustanovitve in so širše opisani v tej knjigi, se bo pridružil četrti: Senzorske tehnologije. Senzorji so ključno področje visokih tehnologij, ki nenehno pridobiva na obsegu in pomenu, tako v teoretskih izhodiščih kot v aplikacijah. V Sloveniji je na tem področju doseženo že dokaj pomembno poznavanje stanja in razvojnih trendov senzorskih tehnologij. To znanje bo v okviru MPŠ povezano in usmerjeno v visokotehnološke razvojne napore proizvodnje in storitvenega sektorja. Z močno podporo potencialnih zaposlovalcev je zasnovan multidisciplinarni program za doktorski študij senzorskih tehnologij, ki ga bo izvajalo blizu štirideset učiteljev – vodilnih raziskovalcev iz 15 visokošolskih in raziskovalnih institucij (7 domačih, 8 tujih). Program vključuje fizikalne in kemijske senzorje, senzorje za ionizirajoče fotone in delce, biosenzorje, pomen informacijsko-komunikacijskih tehnologij na področju senzorjev ter principe in aplikacije meroslovja v senzorskih tehnologijah.

Motivating candidates to study at the IPS

Informing candidates interested in IPS studies is carried out via authorised government institutions, communication tools (the IPS website, publications in newspapers, on the radio and on TV), invitations to JSI and IPS events and via research and industrial partners of the IPS. However, the most efficient way of communicating is personal contact between the potential candidates and the IPS students and professors. The enrolment in the doctoral studies is generally limited to 55 candidates. The IPS enrols predominantly students with outstanding achievements in their undergraduate studies – the average grade of the undergraduate studies for all the students enrolled in the IPS for the first time is above 8.5 (for example, in the 2012/2013 academic year, the average grade was 8.64, and 8.73 in 2013/2014). However, undergraduate studies' achievements are not the sole criterion. The candidates for enrolment are also invited to an interview, where their creative disposition and research potential are evaluated. The potential employers of the candidates play an important role here, especially in the research and economic fields. At least one quarter of the IPS students come from abroad, so far mostly from Europe (Albania, Belarus, Bosnia and Herzegovina, Montenegro, Finland, Croatia, Italy, Kosovo, Macedonia, Poland, Portugal, Romania, Russia, Serbia, Spain and Ukraine), Asia (India, Pakistan, Sri Lanka and Uzbekistan), as well as from Mexico and Brazil, with whom we are discussing a closer collaboration.

Designing the study programmes

The IPS designs its study programmes on interdisciplinary and multidisciplinary fields and gives priority to high technologies. The integration of particular disciplines in the framework of the programmes is carried out according to two quality criteria: the science criterion demands highly developed and rapidly progressive theoretical knowledge, while the development criterion emphasises the importance of the acquired knowledge for the progress of technologies in accordance with the possibilities for the transfer of knowledge onto the development efforts of industry and the social sector. In doing so, the IPS considers the current needs of industry as well as a long-term orientation towards sustainable development.

The three programmes carried out at the IPS since the establishment of the school and described in detail in this book, will soon be joined by a fourth programme: Sensor Technologies. Sensors are an important area of high technologies and are constantly gaining in their scope and importance, in theory as well as in application. In Slovenia, important knowledge of the situation and research trends in the field of sensor technologies has already been acquired. The IPS will integrate and direct this knowledge into high-technology development efforts for production and the service industry. With the strong support of potential employers we have designed a multidisciplinary study programme for sensor technologies that will be carried out by nearly 40 professors – leading researchers from 15 higher-education and research institutions (7 national, 8 foreign). The programme includes physical and chemical sensors, sensors for ionising photons and particles, biosensors, the importance of information and communication technologies in the field of sensors and the principles and applications of metrology in sensor technologies.

Kakovost učiteljev MPŠ

Za vsako šolo, še posebej na podiplomski ravni, je kakovost odvisna v največji meri od kakovosti učiteljev – mentorjev. Na MPŠ deluje 179 visokošolskih učiteljev, med njimi 76 rednih profesorjev, 43 izrednih profesorjev in 60 docentov ter 12 asistentov. Ker je podiplomski študij na MPŠ zahteven raziskovalno-izobraževalni proces, je delež učiteljev z višjimi nazivi večji. Učitelji so k sodelovanju v programih MPŠ povabljeni iz vrst mednarodno visoko uveljavljenih raziskovalcev, ki so nosilci ali pomembni raziskovalci v zahtevnih mednarodnih projektih. Postopki izvolitve v visokošolske nazive so na MPŠ zelo strogi in zahteve po večini prekašajo le-te pri podobnih institucijah. Ker MPŠ stremi k najbolj kakovostnemu "študiju po meri", izvolitev učitelja MPŠ v naziv še ni zadostni pogoj, podvrženi so še drugemu izboru: študenti v sodelovanju z mentorji in zaposlovalci ter ob presoji in soglasju študijskih organov ciljano izbirajo študijske predmete in s tem svoje učitelje. Razmerje učitelj : študent je na MPŠ praviloma več kot 1 : 2.

Mentorji in somentorji MPŠ

Magistrsko ali doktorsko delo je glavni del študija na MPŠ, zato je kakovost zasnove teme magistrskega ali doktorskega dela v ospredju vsega sodelovanja študenta z učitelji in še posebej z mentorjem. Svetovanje sega od prvega prihoda študentov na MPŠ, ko se začne pogovor o njihovem "študiju po meri", praviloma na prodornem raziskovalnem ali na gospodarsko-razvojno usmerjenem področju, prek oblikovanja raziskovalne teme, ki jo presodi študijska komisija in odobri senat MPŠ, do skrbnega spremljanja realizacije magistrskega ali doktorskega dela. Zato je posebna pozornost MPŠ namenjena izboru mentorjev, ki poteka v dveh obdobjih. Prvi mentor pomaga študentu kot svetovalec že pred vpisom, zlasti pri sestavi individualno izbranega študijskega programa, ter ga spremlja v prvem semestru. Po tem času študent ohrani ali pa zamenja svojega mentorja. Če tema pokriva več specialnih področij, dobi študent enega ali več somentorjev. V neposredno razvojno usmerjenih temah dobi tudi industrijskega somentorja, ki pomaga ciljno usmerjati njegovo raziskovalno delo in dosežke sproti prenašati v podjetje. Bistvena značilnost kakovosti je, da študent dela v mentorjevi raziskovalni skupini in je mentor zanj dosegljiv praviloma vsak dan.

Zagotavljanje vrhunske raziskovalne opreme

V svojem raziskovalno-izobraževalnem programu imajo študenti MPŠ dostop do vrhunske raziskovalne opreme v okviru partnerskih inštitutov (IJS, IMT in NIB) ter še posebej v okviru centrov odličnosti, zlasti Centra odličnosti nanoznanosti in nanotehnologije (CO NIN), Centra odličnosti za integrirane pristope v kemiji in biologiji proteinov (CO CIPKeBiP), Centra odličnosti Napredni nekovinski materiali s tehnologijami prihodnosti (CO NAMASTE). V okviru projektov za gospodarske partnerje se študenti MPŠ tudi neposredno vključujejo v njihove razvojne laboratorije.

Quality of IPS Professors

The quality of every school, especially at the postgraduate level, depends to a great extent on the quality of its professors – supervisors. The IPS has 179 higher-education teachers, among them 76 full professors, 43 associate professors, 60 assistant professors and 12 assistants. Postgraduate studies at the IPS are a demanding research and education process; consequently, the share of teachers with higher scientific titles is larger. Teachers are invited to participate in the IPS programmes from among internationally acclaimed researchers who are the project leaders or important researchers in complex international projects. Habilitation procedures at the IPS are very strict and the requirements are mostly more demanding than in similar institutions. Because the IPS aims to achieve quality studies that are tailored to students' needs, habilitation of IPS professors is not the sole requirement; they also need to pass other types of selection: the students in collaboration with supervisors and employers and with the appraisal and agreement of study bodies select courses and consequently their teachers. The professor : student ratio at the IPS is generally better than 1 : 2.

IPS Supervisors and Co-supervisors

Master's theses and doctoral dissertations are an essential part of the studies at the IPS. The quality of designing the topic of the master's thesis or doctoral dissertation is therefore the central focus of the collaboration between the students and professors, especially the supervisor. Their guidance is important from the student's first visit to the IPS, when conversations about the studies tailored to the student's needs first begin, generally in a progressive research field or in a field oriented towards economic development, to determining the research topic, examined by the study commission and approved by the IPS senate, to closely monitoring the realisation of the master's thesis or doctoral dissertation. Special attention at the IPS is devoted to the selection of supervisors, which takes place in two periods. The first supervisor helps the student as an adviser already before the enrolment, especially in designing the curriculum, and in the first semester. After that period, the student keeps or substitutes the supervisor. If the topic is spread over several fields, the student is assigned one or more co-supervisors. If the topics are directly development oriented, the student is also assigned an industrial co-supervisor, who helps directing the student's research work and transferring the achievements directly to the company. The essential feature of the quality is that the student works in the supervisor's research group and that the supervisor is normally accessible to the student every day.

Ensuring high-quality research equipment

The IPS students can use high-quality research equipment in their research and education programme in the framework of the partner institutes (JSI, IMT and NIB), and especially in the framework of the centres of excellence, particularly the Centre of Excellence: Nanoscience and Nanotechnology (CO NIN), Centre of Excellence for Integrated Approaches in Chemistry and Biology of Proteins (CO CIPKeBiP), and the Centre of Excellence Advanced Materials and Technologies for the Future (CO NAMASTE). In the framework of the projects for industrial partners, the IPS students are also directly included in their research laboratories.

Pridobivanje mednarodnih izkušenj

Kot že ime šole pove, je mednarodno sodelovanje vključeno v vse dejavnosti MPŠ. Sodelovanje je vzpostavljeno z blizu sto univerzami in raziskovalnimi inštituti. Študenti MPŠ so neposredno vključeni povprečno v več kot trideset projektov v okviru EU in več kot petdeset drugih mednarodnih projektov. V tem okviru se izpopolnjujejo na tujih univerzah in inštitutih, tuji profesorji tudi redno predavajo na MPŠ. Mentorji organizirajo za najboljše študente tudi podoktorski študij na mednarodno vodilnih univerzah in inštitutih. V letu 2013 je bilo 210 doktorjev in magistrov MPŠ zaposlenih v 23 državah (Avstrija, Belgija, Belorusija, Bosna in Hercegovina, Brazilija, Črna gora, Danska, Grčija, Hrvaška, Indija, Italija, Kitajska, Kosovo, Makedonija, Nemčija, Portugalska, Romunija, Srbija, Španija, Švica, Ukrajina, Velika Britanija in ZDA). Večina se vključuje v Alumni klub MPŠ, predvsem za sodelovanje v raziskovalnih projektih, svetovanje študentom in pospeševanje gospodarskih stikov.

- Dolgoročni sporazumi o mednarodnem sodelovanju

  Te ima MPŠ formalno sklenjene z 29 tujimi univerzami in inštituti:
  - Adam Mickiewicz University, Poznań, Poljska
  - Anadolu University, Eskişehir, Turčija
  - Babes-Bolyai University, Cluj-Napoca, Romunija
  - Bauman University, Moskva, Rusija
  - Bulgarian Academy of Sciences, Sofija, Bolgarija
  - Joint Institute for Nuclear Research, JINR, Dubna, Rusija
  - Korea Advanced Institute of Science and Technology, KAIST, Seul, Južna Koreja
  - Politechnika Wroclawska, Poljska
  - Roskilde University, Danska
  - Tallinn University of Technology, Estonija
  - Technical University of Cluj-Napoca, Romunija
  - Tokushima Bunri University, Tokio, Japonska
  - Tomas Bata University in Zlin, Češka
  - Universidad Nacional del Sur, Bahía Blanca, Argentina
  - Universidade de São Paulo, Brazilija
  - Università degli Studi di Perugia, Italija
  - Universitat de Barcelona, Španija
  - Universitatea din Bucuresti, Romunija
  - Université d'Orléans, Francija
  - Université de Lorraine, Nancy, Francija
  - Université François Rabelais, Tours, Francija
  - University of Ioannina, Grčija
  - University of Pannonia, Veszprem, Madžarska
  - University of Porto, Portugalska
  - University of Salerno, Italija
  - University of Udine, Italija
  - Vilnius University, Litva
  - VU University, Amsterdam, Nizozemska
  - Vytautas Magnus University, Kaunas, Litva

Acquiring international experience

As is already evident from the name of the school, international collaboration is included in all its activities. The IPS collaborates with nearly one hundred universities and research institutes. The IPS students are directly included in on average more than 30 EU projects and more than 50 other international projects. In this framework, the students broaden their knowledge also at foreign universities and institutes, while visiting professors also regularly hold lectures at the IPS. The supervisors also organise postdoctoral studies at leading international universities and institutes for the best students. In 2013, 210 IPS doctors and masters were employed in 23 countries (Austria, Belarus, Belgium, Bosnia and Herzegovina, Brazil, China, Croatia, Denmark, Great Britain, Greece, India, Italy, Kosovo, Macedonia, Montenegro, Germany, Portugal, Romania, Serbia, Spain, Switzerland, Ukraine, and USA). Most of them joined the IPS Alumni Club, especially in order to participate in research projects, as well as to advise students and establish contacts with industry.

- *Long-term agreements on international collaboration*

  The IPS has formal agreements with 29 foreign universities and institutes:
  - *Adam Mickiewicz University, Poznań, Poland*
  - *Anadolu University, Eskişehir, Turkey*
  - *Babes-Bolyai University, Cluj-Napoca, Romania*
  - *Bauman University, Moskva, Russia*
  - *Bulgarian Academy of Sciences, Sofia, Bulgaria*
  - *Joint Institute for Nuclear Research, JINR, Dubna, Russia*
  - *Korea Advanced Institute of Science and Technology, KAIST, Seoul, South Korea*
  - *Politechnika Wroclawska, Poland*
  - *Roskilde University, Denmark*
  - *Tallinn University of Technology, Estonia*
  - *Technical University of Cluj-Napoca, Romania*
  - *Tokushima Bunri University, Tokyo, Japan*
  - *Tomas Bata University in Zlin, Czech Republic*
  - *Universidad Nacional del Sur, Bahía Blanca, Argentina*
  - *Universidade de São Paulo, Brazil*
  - *Università degli Studi di Perugia, Italy*
  - *Universitat de Barcelona, Spain*
  - *Universitatea din Bucuresti, Romania*
  - *Université d'Orléans, France*
  - *Université de Lorraine, Nancy, France*
  - *Université François Rabelais, Tours, France*
  - *University of Ioannina, Greece*
  - *University of Pannonia, Veszprem, Hungary*
  - *University of Porto, Portugal*
  - *University of Salerno, Italy*
  - *University of Udine, Italy*
  - *Vilnius University, Lithuania*
  - *VU University, Amsterdam, the Netherlands*
  - *Vytautas Magnus University, Kaunas, Lithuania*

- Mednarodno sodelovanje profesorjev MPŠ

  Gostujoči profesorji MPŠ prihajajo iz 12 držav (Avstrija, Belgija, Finska, Francija, Hrvaška, Japonska, Nemčija, Norveška, Romunija, Švica, Velika Britanija, ZDA). To so po pravilu vrhunski znanstveniki – eksperti za področja izbrana glede na dosežke najbolj propulzivnih znanosti in interese gospodarstva. Med njimi so profesorji mednarodno uglednih univerz:

  – ETH Zürich
  – Imperial College London
  – Max-Planck-Institut für Biochemie in Martinsried
  – Technische Universität Clausthal
  – CNRS Nancy
  – École polytechnique fédérale de Lausanne
  – NILU – Norwegian Institute for Air Research, Kjeller
  – University of Oulu
  – Universiteit Gent
  – Graz University of Technology
  – Université Paris-Sud
  – Université Francois Rabelais, Tours
  – Universität Wien
  – Universiteit Antwerpen
  – Technische Universität Darmstadt
  – North Carolina State University
  – Keio University

Profesorji MPŠ neposredno sodelujejo z vodilnimi raziskovalnimi skupinami blizu sto univerz in v to sodelovanje vključujejo študente MPŠ.

Objavljanje raziskovalnih dosežkov

Kakovost doktoratov na MPŠ visoko prekaša dosežke podobnih visokošolskih institucij: uradno predpisani pogoj je ena objava dosežkov v reviji s faktorjem vpliva ali patent, na MPŠ pa so povprečno 3 in večkrat do 10 objav, tudi v najbolj uglednih znanstvenih revijah (Science, Nature), in več patentov ter prenosov v proizvodnjo.

- *International collaboration of IPS Professors*

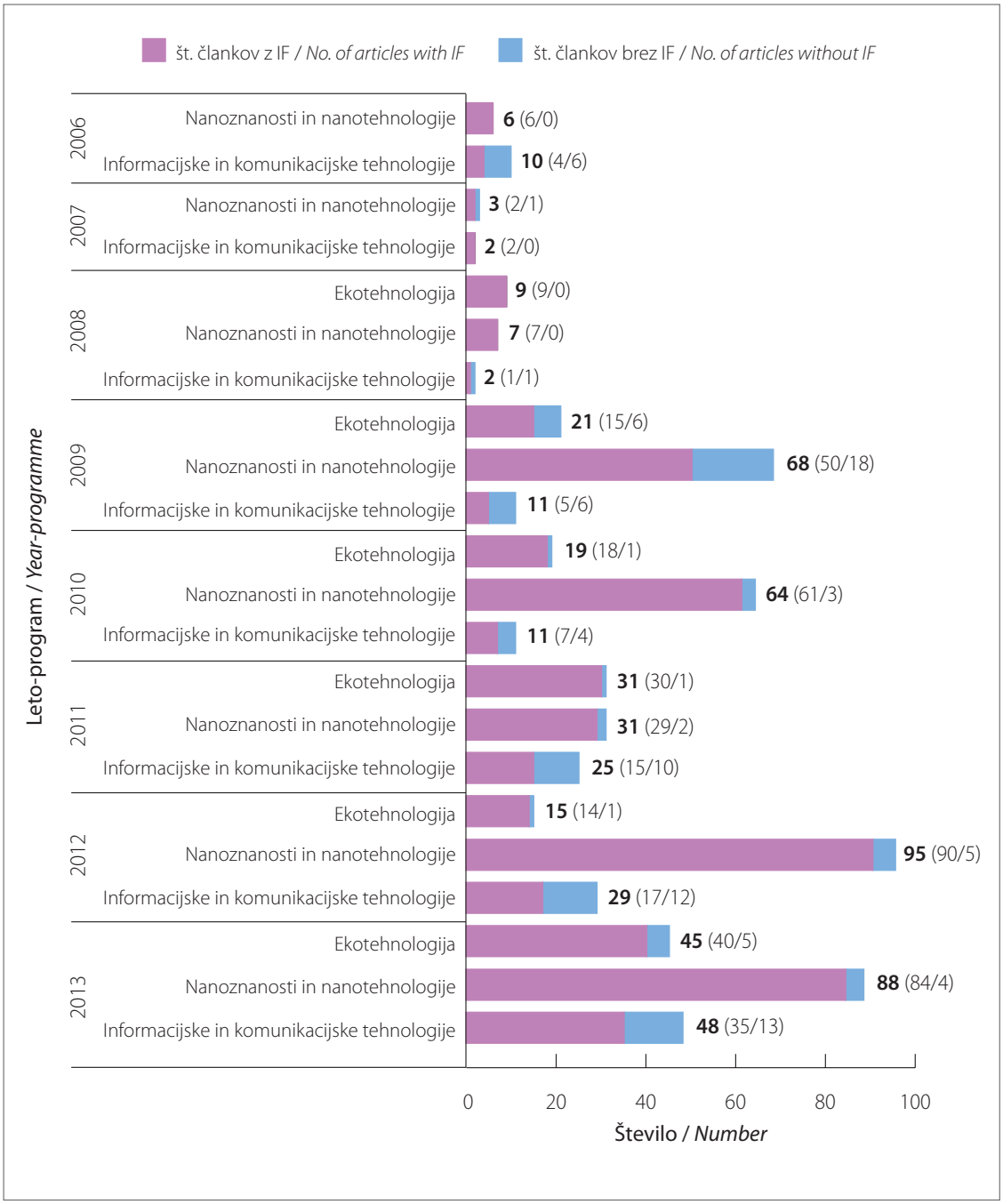
  IPS visiting professors come from 12 countries (Austria, Belgium, Croatia, Finland, France, Germany, Great Britain, Japan, Norway, Romania, Switzerland, USA). All of them are acclaimed scientists – experts in the fields selected on the basis of achievements in the most rapidly developing sciences and industrial interest. Among them are professors from internationally acclaimed universities:

  – *ETH Zürich*
  – *Imperial College London*
  – *Max-Planck-Institut für Biochemie in Martinsried*
  – *Technische Universität Clausthal*
  – *CNRS Nancy*
  – *École polytechnique fédérale de Lausanne*
  – *NILU – Norwegian Institute for Air Research, Kjeller*
  – *University of Oulu*
  – *Universiteit Gent*
  – *Graz University of Technology*
  – *Université Paris-Sud*
  – *Université Francois Rabelais, Tours*
  – *Universität Wien*
  – *Universiteit Antwerpen*
  – *Technische Universität Darmstadt*
  – *North Carolina State University*
  – *Keio University*

The IPS professors directly collaborate with the leading research groups from nearly 100 universities – where they also include the IPS students.

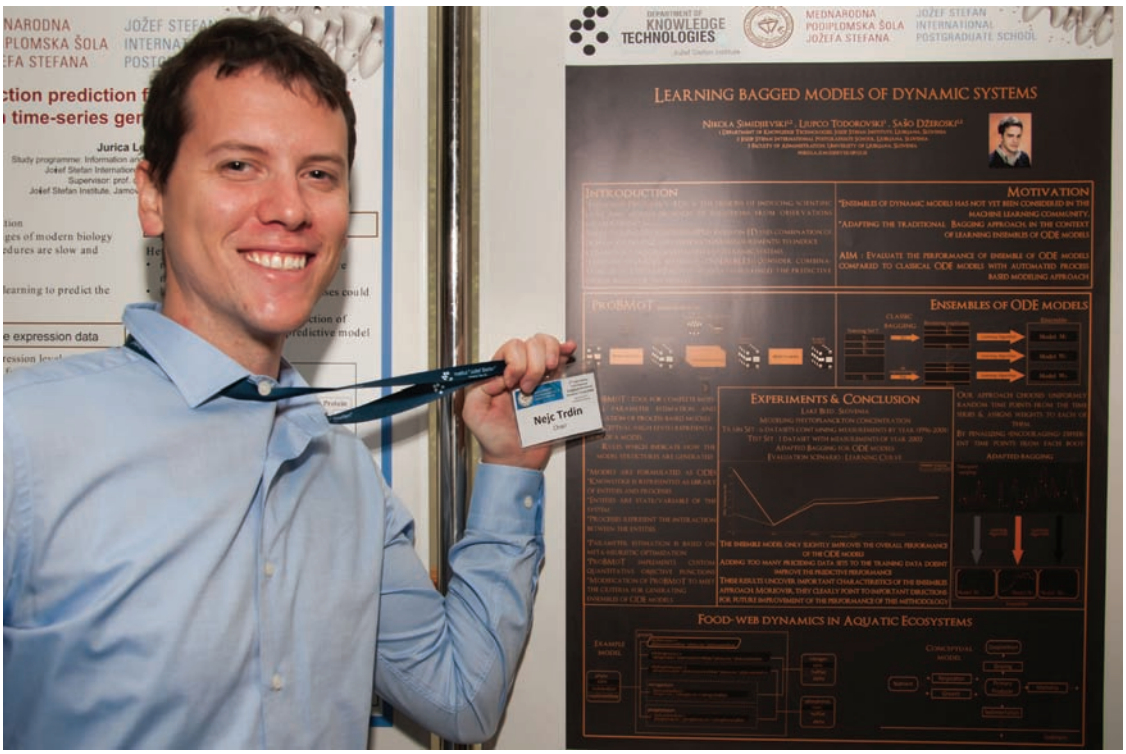
Publishing of research achievements

The quality of the doctoral dissertations at the IPS significantly exceeds the achievements from similar higher-education institutions: the officially set requirement is one publication of research achievements in a journal with impact factor or a patent, whereas the IPS students have 3 publications on average and even up to 10, also in the most prominent scientific journals (Science, Nature) and several patents and transfers into production.



Število znanstvenih objav študentov MPŠ po programih (zaključene disertacije)

The number of scientific publications of IPS students by programmes (defended dissertations)

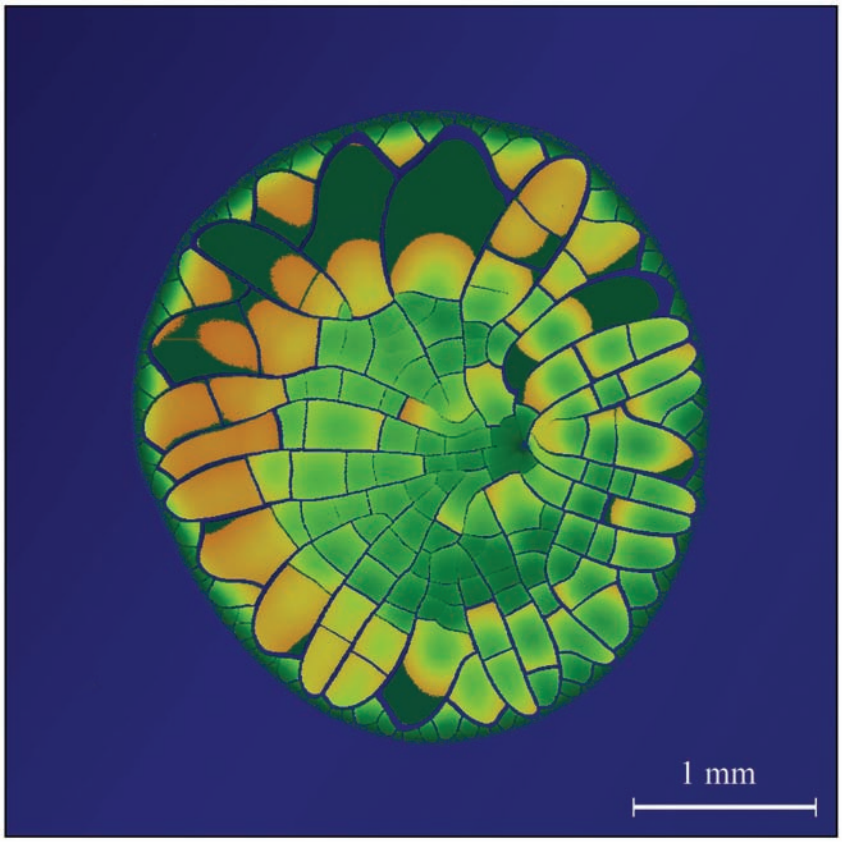


Glavni pogon Študentskih konferenc MPŠ je predsednik Študentskega sveta.

The main drive of Students' Conferences is the President of the Students' Council.

Gojenje znanstvene kulture

Znanost je zakladnica znanja, kultura je nosilka vrednot. Vsaka zase sta torzo, le tesno prepleteni sta temelj modrosti, ki je pogoj za kakovost življenja, še posebej v kriznih pogojih. Zato MPŠ ne izvaja le raziskovalno-izobraževalnega dela, med študijem tudi načrtno privzgaja znanstveno pogojene kulturne vrednote. Mednje sodi zlasti nenehna težnja k odklanjanju predsodkov in približevanju resnici, kar terja visoko razvite sposobnosti objektivnega opazovanja, postavljanja hipotez in njihovega načrtnega preverjanja. Pomembne vrednote znanstvene kulture, ki jih MPŠ goji, so tudi sposobnost za ustvarjalno skupinsko delo, kritičnost v opredeljevanju dosežkov in poštenost v njihovih predstavitvah. To vključuje tudi strnjenost in natančnost oblikovanja sporočil ter skrb za gojenje jezika za njihovo širše razumevanje. Kot znanstvene vrednote goji MPŠ tudi spodbujanje uporabe znanstvenih dosežkov v gospodarskem in socialnem razvoju ob celovitem predvidevanju tako pozitivnih kot morebitnih negativnih posledic. Ne nazadnje namenja MPŠ izrazito skrb razvoju težnje za medkulturno in mednarodno sodelovanje in solidarnost. V tem sklopu goji MPŠ tudi napore za celovito obvladovanje dvojezičnosti – materinega in svetovnega jezika.



Posnetek profila kapljice vodne suspenzije $Pb(Zr_{0.53}Ti_{0.47})O_3$, nanešene na silicijevo podlago z brizgalnim tiskanjem, po sušenju.

Profile image of a drop of the $Pb(Zr_{0.53}Ti_{0.47})O_3$ aqueous suspension, deposited by inkjet printing on a silicon substrate, after drying.

Developing the culture of science

Science is a treasury of knowledge; culture is a carrier of value. Each on its own is a body, closely intertwined into the foundation of wisdom, which is the basis for the quality of life, especially in times of crisis. This is why the IPS not only offers research and educational work, but also puts emphasis on scientific cultural values. Among them a constant need for refusing prejudice and approaching truth, which demands highly developed abilities of objective observance, forming hypotheses, and planning their examination. The IPS cultivates important values for the culture of science, among them the ability to be creative in teamwork, to be critical in assessing achievements, and to convey honesty in their presentation. In this light, the IPS supports conciseness and accuracy in formulating messages, and care for cultivating language for a wider understanding. The IPS is very encouraging in applying scientific achievements in economic and social development within the comprehensive predication of positive and possible negative consequences. Last but not least, the IPS expresses concern to develop the need for cross-cultural collaboration and solidarity. The IPS also stands for encouraging a comprehensive ability of bilingualism, the mother tongue and the language of the world.

MPŠ 2014 – Vabljeno predavanje Davida Proberta, predstojnika Centra za tehnološki management Univerze Cambridge

IPS 2014 – Invited lecture given by David Probert, Head of the Centre for Technology Management, University of Cambridge

PRIZNANJA

JAVNA PRIZNANJA UČITELJEM MPŠ

Mnogim učiteljem MPŠ so bila za njihove dosežke podeljena najvišja domača priznanja.

Zoisove nagrade

Blinc Robert (2008)
Kornhauser Aleksandra (1997)
Kosec Marija (2006)
Muševič Igor (2009)
Mihailović Dragan (2002)
Stavber Stojan (2000)
Turk Boris (2011)
Turk Dušan (2005)
Turk Vito (1998)
Žemva Boris (2011)

Ambasadorji znanosti

Blinc Robert (1991)
Emri Igor (2001)
Horvat Milena (2002)
Kosec Marija (2003)
Kornhauser Aleksandra (1991)
Lavrač Nada (1997)
Peterlin Matija (2008)
Šali Andrej (2007)
Turk Vito (1993)
Žemva Boris (2001)

Zoisova priznanja

Arčon Iztok (2006), Blinc Robert (2001), Dražić Goran (2000), Kabanov Viktor (2007), Kosmač Tomaž (2003), Križaj Igor (2004), Kutnjak Zdravko (2006), Lavrač Nada (2013), Malič Barbara (2010), Milačič Radmila (1999), Milošev Ingrid (2011), Mrzel Aleš (2001), Muševič Igor (2004), Novak Krmpotič Saša (2003, 2013), Novak Franc (1999), Remškar Maja (2001), Turk Boris (2001), Zalar Boštjan (2005).

Puhova priznanja

Cvelbar Uroš (2011), Kosec Marija (2009), Kosmač Tomaž (2007), Mekjavić Igor (2007), Mozetič Miran (2011), Vrančić Damir (2012).

Pred tem so bile podeljene:

Kidričeve nagrade

Blinc Robert (1961, 1975)
Tadić Bosiljka in Pirc Raša (1986)
Turk Vito (1984)
Ude Lojze (1978)
Žemva Boris (1989)

AWARDS

PUBLIC AWARDS CONFERRED ON IPS PROFESSORS

Many of the IPS professors were presented with the highest national awards for their achievements.

Zois Awards

Blinc Robert (2008)
Kornhauser Aleksandra (1997)
Kosec Marija (2006)
Muševič Igor (2009)
Mihailović Dragan (2002)
Stavber Stojan (2000)
Turk Boris (2011)
Turk Dušan (2005)
Turk Vito (1998)
Žemva Boris (2011)

Ambassadors of Science

Blinc Robert (1991)
Emri Igor (2001)
Horvat Milena (2002)
Kosec Marija (2003)
Kornhauser Aleksandra (1991)
Lavrač Nada (1997)
Peterlin Matija (2008)
Šali Andrej (2007)
Turk Vito (1993)
Žemva Boris (2001)

Zois Certificates of Recognition

Arčon Iztok (2006), Blinc Robert (2001), Dražić Goran (2000), Kabanov Viktor (2007), Kosmač Tomaž (2003), Križaj Igor (2004), Kutnjak Zdravko (2006), Lavrač Nada (2013), Malič Barbara (2010), Milačič Radmila (1999), Milošev Ingrid (2011), Mrzel Aleš (2001), Muševič Igor (2004), Novak Krmpotič Saša (2003, 2013), Novak Franc (1999), Remškar Maja (2001), Turk Boris (2001), Zalar Boštjan (2005).

Puh Certificates of Recognition

Cvelbar Uroš (2011), Kosec Marija (2009), Kosmač Tomaž (2007), Mekjavić Igor (2007), Mozetič Miran (2011), Vrančić Damir (2012).

Previously, the following awards were presented:

Kidrič Awards

Blinc Robert (1961, 1975)
Tadić Bosiljka and Pirc Raša (1986)
Turk Vito (1984)
Ude Lojze (1978)
Žemva Boris (1989)

Nagrade sklada Borisa Kidriča

Emri Igor (1983), Jerman Blažič Borka (1987), Juričić Đani (1988), Kobe Spomenka (1987, 1992), Kosmač Tomaž (1984), Lahajnar Gojmir (1988), Lavrač Nada (1986), Lenarčič Jadran (1987), Makovec Darko (1994), Mihailović Dragan (1988), Mozetič Igor (1986), Muševič Igor (1993), Novak Franc (1989), Nemec Bojan (1987), Pirc Raša (1979), Prodan Albert (1981), Pungerčar Jože (1991), Ravnikar Maja (1989), Sočan Lojze (1980), Stegnar Peter (1973), Trobec Roman (1989), Turk Vito (1968, 1979), Ude Lojze (1972), Žel Jana (1989), Žlajpah Leon (1987).

Nekatere med najvišjimi tujimi nagradami in priznanji, ki so jih prejeli učitelji MPŠ:

Robert Blinc

- ISMAR Nagrada Mednarodne unije za magnetne resonance (1977)
- Spominska medalja "Anatoly Nikolajevič Podgornij" Inženirske akademije Ukrajine, Srebrni znak predsedstva Mednarodne inženirske akademije IAE, Moskva in Zlati znak predsedstva Ruske inženirske akademije, Moskva (2001)
- Nuclear Hyperfine Interaction Award«, International Society of Nuclear Quadrupole Resonance (2004)

Aleksandra Kornhauser

- Laurent Lavoisier Medal, Académie de Pharmacie, Pariz (1987)
- Robert Brasted Memorial Award, American Chemical Society, Washington (1990)
- Honda Prize, Tokio (1999)

Dragan Mihailović

- Honorary Member of the High Table, Christ Church College, University of Oxford (1986)
- Fulbright Fellow (1989)
- Panel Member, European Research Council (2013)

Vito Turk

- The Heyrovsky Silver Medal for scientific achievements in chemistry, Czechoslovak Academy of Sciences, Praga (1988)
- Member, European Molecular Biology Organisation-EMBO (1999)
- Diplôme d'Honneur, Federation of European Biochemical Societies-FEBS (1999)

Boris Žemva

- Visiting Miller Professor, University of California, Berkeley (1993)
- Alexander von Humboldt Research Award (1999)
- The Award of the American Chemical Society (2006)

Boris Kidrič Fund Awards

Emri Igor (1983), Jerman Blažič Borka (1987), Juričić Đani (1988), Kobe Spomenka (1987, 1992), Kosmač Tomaž (1984), Lahajnar Gojmir (1988), Lavrač Nada (1986), Lenarčič Jadran (1987), Makovec Darko (1994), Mihailović Dragan (1988), Mozetič Igor (1986), Muševič Igor (1993), Novak Franc (1989), Nemec Bojan (1987), Pirc Raša (1979), Prodan Albert (1981), Pungerčar Jože (1991), Ravnikar Maja (1989), Sočan Lojze (1980), Stegnar Peter (1973), Trobec Roman (1989), Turk Vito (1968, 1979), Ude Lojze (1972), Žel Jana (1989), Žlajpah Leon (1987).

Some of the highest international awards and recognitions *conferred on IPS professors:*

Robert Blinc

ISMAR-Prize 1977 of the International Society for Magnetic Resonance (1977)

Memorial medal "Anatoly Nikolajevič Podgornij" of the Engineering Academy of Ukraine, Silver Medal of the International Academy of Engineering IAE, Moscow and Golden Sign of the Presidency of the Russian Academy of Engineering, Moscow (2001)

Nuclear Hyperfine Interaction Award«, International Society of Nuclear Quadrupole Resonance (2004)

Aleksandra Kornhauser

Laurent Lavoisier Medal, Académie de Pharmacie, Paris (1987)

Robert Brasted Memorial Award, American Chemical Society, Washington (1990)

Honda Prize, Tokyo (1999)

Dragan Mihailović

Honorary Member of the High Table, Christ Church College, University of Oxford (1986)

Fulbright Fellow (1989)

Panel Member, European Research Council (2013)

Vito Turk

The Heyrovsky Silver Medal for scientific achievements in chemistry, Czechoslovak Academy of Sciences, Prague (1988)

Member, European Molecular Biology Organisation-EMBO (1999)

Diplôme d'Honneur, Federation of European Biochemical Societies-FEBS (1999)

Boris Žemva

Visiting Miller Professor, University of California, Berkeley (1993)

Alexander von Humboldt Research Award (1999)

The Award of the American Chemical Society (2006)

NAJVIŠJA PRIZNANJA, KI JIH PODELJUJE MPŠ

Zlati znak MPŠ

To je najvišje priznanje profesorjem MPŠ – prejeli so ga:

Aleksandra Kornhauser (2006)
Robert Blinc (2007)
Vito Turk (2007)

Prof. dr. Aleksandra Kornhauser-Frazer (2006)

Prof. dr. Robert Blinc (2007) Prof. dr. Vito Turk (2007)

Priznanji jima izroča dr. Emil Rojc, predsednik Skupščine MPŠ.

The emblems are presented by Dr. Emil Rojc, President of IPS Assembly.

Medalja Janeza Vajkarda Valvasorja

To je najvišje priznanje partnerjem MPŠ – prejela sta ga:

Franjo Bobinac, Gorenje (2008)
Ivan Atelšek, Gorenje (2008)

THE HIGHEST AWARDS CONFERRED BY THE IPS

IPS Golden Emblem

The IPS Golden Emblem is the highest recognition award conferred on IPS professors – award winners:

Aleksandra Kornhauser (2006)
Robert Blinc (2007)
Vito Turk (2007)

Janez Vajkard Valvasor Medal

The Janez Vajkard Valvasor Medal is the highest recognition award conferred on IPS partners – award winners:

Franjo Bobinac, Gorenje (2008)
Ivan Atelšek, Gorenje (2008)

Udeleženci prve podelitve Valvasorjevih nagrad MPŠ 27. 11. 2008 – od leve: dekan MPŠ Robert Blinc, minister za visoko šolstvo, znanost in tehnologijo Gregor Golobič, nagrajenca Ivan Atelšek in Franjo Bobinac, prodekan MPŠ Aleksandra Kornhauser-Frazer, svetovalec dekana Emil Rojc in direktor IJS Jadran Lenarčič.

Participants at the first IPS Valvasor awards ceremony on 27 November 2008 – from left: IPS Dean Robert Blinc, Minister for Higher Education, Science and Technology Gregor Golobič, award winners Ivan Atelšek and Franjo Bobinac, IPS Vice-Dean Aleksandra Kornhauser-Frazer, Dean's Adviser Emil Rojc and JSI Director Jadran Lenarčič.

Upravljanje in strokovna podpora

Upravni organi MPŠ

Dr. Jožica Rejec
Direktorica, Domel Železniki
Predsednica Upravnega odbora MPŠ

»Znanje je za naše gospodarstvo ključnega pomena, saj mora posegati v sam vrh svetovne tekme.«

SKUPŠČINA	**Predsednik**: mag. Mirko Kaluža
UPRAVNI ODBOR	**Predsednica**: dr. Jožica Rejec
AKADEMSKI ZBOR	**Predsednik MPŠ**: prof. dr. Vito Turk
ŠTUDENTSKI SVET	**Predsednik**: Nejc Trdin
SENAT	**Dekan**: prof. dr. Aleksandra Kornhauser-Frazer
	Prodekan za študijske zadeve: prof. dr. Boris Žemva
	Prodekan za raziskovalno dejavnost in kadre: prof. dr. Dragan Mihailović
	Predstojniki programov: • Nanoznanosti in nanotehnologije: prof. dr. Dragan Mihailović • Informacijske in komunikacijske tehnologije: prof. dr. Franc Novak • Ekotehnologija: prof. dr. Milena Horvat
	Vodja raziskovalne skupine: prof. dr. Boštjan Zalar

Management and professional support

IPS Governing Bodies

Dr. Jožica Rejec
Director, Domel Železniki
President of the IPS Governing Board

»Knowledge is of key importance for our economy, as it must strive to reach the very peak of the world competition.«

ASSEMBLY	***President**: MSc Mirko Kaluža*
GOVERNING BOARD	***President**: Dr. Jožica Rejec*
ACADEMIC COUNCIL	***IPS President**: Professor Vito Turk*
STUDENT COUNCIL	***President**: Nejc Trdin*
SENATE	***Dean**: Professor Aleksandra Kornhauser-Frazer*
	***Vice-Dean for Study Matters**: Professor Boris Žemva*
	***Vice-Dean for Research and Personnel**: Professor Dragan Mihailović*
	***Heads of Programmes**:* • ***Nanosciences and Nanotechnologies**: Professor Dragan Mihailović* • ***Information and Communication Technologies**: Professor Franc Novak* • ***Ecotechnology:** Professor Milena Horvat*
	***Head of Research Group**: Professor Boštjan Zalar*

KOORDINACIJA IZVAJANJA NALOG

To koordinacijo izvaja kot delovno telo razširjena koordinacija dekana, ki podrobno obravnava osnutke in jih po obdelavi posreduje kot predloge pristojnim organom v odločanje.

Člani razširjene koordinacije so:

- dekan, ki predlaga obravnave zadev in vodi seje,
- predstojniki programov in njihovi namestniki, vodja in namestnik vodje raziskovalne skupine ter svetovalci dekana, ki presojajo predloge in prispevajo k njihovi optimizaciji,
- predsednik Študentskega sveta pri obravnavi nalog, ki zadevajo študente,
- glavni tajnik in člani tajništva, ki so odgovorni za izvajanje obravnavanih nalog,
- po potrebi tudi posebej vabljeni eksperti za obravnavane naloge.

K delu koordinacije je vabljen tudi predsednik MPŠ.

COORDINATION OF WORK

The coordination of work is carried out by the Extended Coordination of the Dean, as a working body, which discusses in detail the drafts and then submits the propositions to authorized bodies for a decision.

Members of the Extended Coordination:

- *The Dean, who suggests the matters for discussion and conducts the meetings.*
- *Heads of programmes and their deputies, Head and Deputy Head of the research group, and the Dean's advisers, who discuss the propositions and contribute to their optimisation.*
- *President of the Student Council, who participates in student-related discussions.*
- *Secretary-General and the members of the IPS Office, who are responsible for the execution of the tasks discussed in the meetings.*
- *Other experts in particular tasks, invited if necessary.*

The President of IPS is invited to cooperate.

Dekan ***Dean*** Professor Aleksandra Kornhauser-Frazer	**Prodekan** ***Vice-Dean*** Professor Boris Žemva	**Prodekan** **Predstojnik NANO** ***Vice-Dean*** ***Head, NANO*** Professor Dragan Mihailović	**Predstojnik IKT** ***Head, ICT*** Professor Franc Novak	**Predstojnik EKO** ***Head, ECO*** Professor Milena Horvat
Glavni tajnik ***Secretary-General*** Professor Aleksander Zidanšek	**Namestnik predstojnika NANO** ***Deputy Head, NANO*** Professor Spomenka Kobe	**Namestnik predstojnika NANO** ***Deputy Head, NANO*** Professor Dušan Turk	**Namestnik predstojnika IKT** ***Deputy Head, ICT*** Professor Nada Lavrač	**Namestnik predstojnika EKO** ***Deputy Head, ECO*** Professor Radmila Milačič
Predsednik Študentskega sveta ***President, Students' Council*** Nejc Trdin	**Svetovalec dekana** ***Advisor to the Dean*** Professor Barbara Malič	**Svetovalec dekana** ***Advisor to the Dean*** Dr. Emil Rojc	**Predstojnik Raziskovalne skupine MPŠ** ***Head, IPS Research group*** Professor Boštjan Zalar	**Namestnik predstojnika Raziskovalne skupine MPŠ** ***Deputy Head, IPS Research group*** Professor Zdravko Kutnjak

TAJNIŠTVO MPŠ

Prof. dr. Aleksander Zidanšek
Glavni tajnik

»Danes so uspešni tisti, ki novo znanje hitro in načrtno prenašajo v svoje delo in odločanje.«

IZVAJANJE STROKOVNE PODPORE

Delo za izvajanje upravno-administrativnih in strokovno-tehničnih nalog je organizirano po sektorjih:

- **študijski sektor za raziskovalno-izobraževalne naloge**: vodi Tadeja Samec

- **poslovni sektor za gospodarjenje, finance in delo z industrijo**: vodi mag. Sergeja Vogrinčič

- **pravni sektor za pravne, upravne in kadrovske naloge**: vodi Margareta Borsellino Srebotnjak

- **sektor za informiranje in dokumentacijo**: vodi Maša Matijašević

IPS ADMINISTRATION

Professor Aleksander Zidanšek
Secretary-General

> *»Success belongs to those who transfer new knowledge quickly and systematically into their work and decision-making.«*

EXECUTION OF PROFESSIONAL SUPPORT

In order to execute the management and administrative as well as professional and technical tasks, the work is organised into sectors:

- ***Study sector for research and education tasks**:*
  Head, Tadeja Samec
- ***Business sector for management, finance and collaboration with industry**:*
  Head, MSc Sergeja Vogrinčič
- ***Legal sector for legal, administrative and personnel tasks**:*
  Head, Margareta Borsellino Srebotnjak
- ***Sector for information and documentation**:*
  Head, Maša Matijašević

Tajništvo MPŠ tehnično podpira tudi Študentske konference
Technical support of Students' Conferences by IPS administration

GLAVNI AKTI MPŠ

Vsi akti so redno dopolnjevani v skladu s predpisi in potrebami ter dosegljivi na spletni strani MPŠ. To so zlasti:

- **Statut MPŠ**:
  https://www.mps.si/dokumenti/splet/dokumentiosoli/STATUT-MPS.pdf

- **Katalog informacij javnega značaja**:
  https://www.mps.si/dokumenti/splet/dokumentiosoli/Katalog_informacij_javnega_znacaja.pdf

- **Poslovnik za zagotavljanje kakovosti**:
  https://www.mps.si/dokumenti/splet/dokumentiosoli/Poslovnik_za_kakovost.pdf

- **Pravilnik o magistrskem in doktorskem študiju**:
  https://www.mps.si/dokumenti/splet/pravilniki/Pravilnik_o_magistrskem_in_doktorskem_studiju.pdf

- **Izpitni pravilnik**:
  https://www.mps.si/dokumenti/splet/pravilniki/Izpitni_pravilnik_MPS.pdf

- **Habilitacije:** Merila za volitve v nazive:
  https://www.mps.si/dokumenti/splet/dokumentizasodelavcejavno/Merila-za-volitve-v-nazive.pdf

- **Habilitacije:** Navodila za pripravo in oddajo vloge za izvolitev v naziv:
  https://www.mps.si/dokumenti/splet/dokumentizasodelavcejavno/Navodila_kandidatom_za_izvolitev.pdf

- **Habilitacije:** Seznam habilitacijskih področij in predmetov:
  https://www.mps.si/dokumenti/splet/dokumentizasodelavcejavno/Seznam_habilitacijskih_podrocij.pdf

PRINCIPAL IPS DOCUMENTS

All the documents are regularly amended in accordance with the regulations and requirements, and can be accessed via the IPS website:

- ***IPS Statute:***
  https://www.mps.si/dokumenti/splet/dokumentiosoli/STATUTE-IPS.pdf

- ***Public Information Catalogue****:*
  https://www.mps.si/dokumenti/splet/dokumentiosoli/Katalog_informacij_javnega_znacaja.pdf

- ***Rules of Procedure for Ensuring Quality****:*
  https://www.mps.si/dokumenti/splet/dokumentiosoli/Poslovnik_za_kakovost.pdf

- ***Regulations on Master and Doctoral Studies****:*
  https://www.mps.si/dokumenti/splet/pravilniki/Regulations_on_Master_and_Doctoral_Studies.pdf

- ***Examination Rules****:*
  https://www.mps.si/dokumenti/splet/pravilniki/Examination_rules_IPS.pdf

- ***Habilitation:*** *Criteria for Appointment to Titles:*
  https://www.mps.si/dokumenti/splet/dokumentizasodelavcejavno/Merila-za-volitve-v-nazive.pdf

- ***Habilitation****: Instructions for the Preparation and Submission of an Application for Appointment to a Title:*
  https://www.mps.si/dokumenti/splet/dokumentizasodelavcejavno/Navodila_kandidatom_za_izvolitev.pdf

- ***Habilitation****: List of Habilitation Fields:*
  https://www.mps.si/dokumenti/splet/dokumentizasodelavcejavno/Seznam_habilitacijskih_podrocij.pdf

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Oblikovanje in postavitev / *Design and layout*
Igor Cerar

Založnik / *Publisher*
Mednarodna podiplomska šola Jožefa Stefana, Ljubljana
Jožef Stefan International Postgraduate School, Ljubljana

Fotografija na naslovnici / *Cover photo*
Detajl iz več visokoločljivostnih posnetkov mikroskopa na atomsko silo sestavljene slike samourejanja nanožic MoSI na površini sljude.
A detail of a large-scale image composed of several high resolution atomic force microscope images presenting self-assembled nanowires on the mica surface.

Fotografiji na notranji strani platnice / *Inside cover photos*
M. Smrke, IJS iz zraka, arhiv IJS; P. Hieng, Panorama Ljubljane, Turizem Ljubljana

Tisk / *Print*
Tiskarna Pleško d.o.o., Ljubljana

Naklada / *Copies*
1000 izvodov

Prva izdaja, prvi natis / *First edition, first printing*: Ljubljana, 2014

Izdajo knjige sta sofinancirala Evropski socialni sklad Evropske unije in Ministrstvo za izobraževanje, znanost in šport Republike Slovenije.

This book was financially supported by the European Union, European Social Fund and the Ministry of Education, Science and Sport of the Republic of Slovenia.

CIP - Kataložni zapis o publikaciji
Narodna in univerzitetna knjižnica, Ljubljana

378.046-021.68(497.4)

MEDNARODNA podiplomska šola Jožefa Stefana (Ljubljana)
Mednarodna podiplomska šola Jožefa Stefana (MPŠ) = Jožef Stefan International Postgraduate School (IPS) / [urednica Aleksandra Kornhauser-Frazer]. - Ljubljana : Mednarodna podiplomska šola Jožefa Stefana = Jožef Stefan International Postgraduate School, 2014

ISBN 978-961-92871-8-7
1. Kornhauser Frazer, Aleksandra
273901312

Foto / Photo: P. Hieng

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ISBN 978-961-92871-8-7
9 789619 287187

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA IZOBRAŽEVANJE, ZNANOST IN ŠPORT

Naložba v vašo prihodnost
OPERACIJO DELNO FINANCIRA EVROPSKA UNIJA
Evropski socialni sklad