

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Karakterizacija kovinskih materialov
Course title:	Characterization of Metallic Materials

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Nanoznanosti in nanotehnologije, 3. stopnja	/	1	1
Nanosciences and Nanotechnologies, 3 rd cycle	/	1	1

Vrsta predmeta / Course type Izbirni / Elective

Univerzitetna koda predmeta / University course code: NANO3-804

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
15	15			15	105	5

**Navedena porazdelitev ur velja, če je vpisanih vsaj 15 študentov. Drugače se obseg izvedbe kontaktnih ur sorazmerno zmanjša in prenese v samostojno delo. / This distribution of hours is valid if at least 15 students are enrolled. Otherwise the contact hours are linearly reduced and transferred to individual work.*

Nosilec predmeta / Lecturer: Prof. dr. Monika Jenko

Jeziki / Predavanja / Lectures: Slovenščina/English
Languages: Vaje / Tutorial: Slovenščina/English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Zaključen študij druge stopnje na eni od naravoslovno tehniških fakultet (fizika, kemija, metalurgija in materiali, strojništvo), medicina, biologija ali na drugih področjih z dokazanim znanjem osnov s področja predmeta.

Prerequisites:

Completed second level studies in natural sciences or engineering or completed second level studies in other fields with proven knowledge of fundamentals in the field of this course (certificates, interview).

Vsebina:

- Kristalna zgradba kovin in zlitin
- Mehanizem elastične in plastične deformacije, mehanizmi utrjevanja kovin in zlitin
- Mehanske lastnosti in mehanski preizkusi kovin in zlitin
- Lezenje: mehanizmi lezenja, deformacija pri lezenju in doba trajanja strojnih elementov in kovinskih konstrukcij
- Karakterizacija mikrostrukture kovin in zlitin na makro, mikro in atomski skali: metalografija, svetlobna, vrstična in presečna

Content (Syllabus outline):

- Crystal structure of metals and alloys
- Elastic and plastic deformation strengthening mechanisms of metals and alloys,
- Mechanical properties and structural mechanical testing of metals and alloys
- Creep: creep mechanisms, determination of residual life of mechanical elements of metallic constructions
- Microstructural characterization of metals and alloys: at macro, micro and atomic scale: metallography, light, electron and transmission microscopy, LM, SEM, TEM)

elektronska mikroskopija (SM, SEM, TEM)

- Analitske spektroskopske metode EDS,WDS
- Karakterizacija teksture kovin in zlitin:
- rentgenski uklon in uklon odbitih elektronov (XRD, GIXRD ,EBSD)
- Karakterizacija, analiza površin kovinskih materialov, tankih in ultra tankih plasti in mejnih površin: Augerjeva elektronska in rentgenska fotoelektronska spektroskopija

- Analytical techniques, EDS, WDS
- Texture characterization of metals and alloys:
- X-ray diffraction and electron back scattered diffraction (XRD,
- Microstructural characterization of thin and ultra thin layers, grain boundaries, interfaces and surfaces of metals and alloys: surface analysis AES and XPS, SIMS, TOF-SIMS

Temeljni literatura in viri / Readings:

- G. E. Dieter: Mechanical Metallurgy, Mc Graw-Hill Book Co, London, 3rd edition 2015.
- Grahame Lawes, Editor: Arthur M. James, Scanning Electron Microscopy and X-ray Microanalysis, 3rd ed. 2003
- V.D.Scott, G.Love, S.J.B.Reed, Editors: Profesor Malcolm J. Cooper, John W. Mason, Quantitative electron-Probe Microanalysis
- Microstructural Characterization of Materials, 2nd Edition David Brandon, Wayne D. Kaplan, ISBN: 978-0-470-02785-1, Wiley Jun 2008
- D. Briggs M.P.Seah (Eds), Practical Surface Analysis, Auger and X-ray Photoelectron Spectroscopy, John Wiley, Chichester 1994
- V. Marinković Meje površine. Univerza v Ljubljani, 1999
- D.Briggs, J.T.Grant (Edts), Surface Analysis by Auger and X-ray Photoelectron Spectroscopy, IMP and Surface Spectra, West Sussex 2003
- Robert DeHoff: Thermodynamics in Materials Science, Taylor & Francis, Boca Raton, 2006

Ciljani izbor in razprava o aktualnih znanstvenih objavah, predvsem v revijah Science, Nature Scientific reports, Nature Materials, Acta Metallurgica, Acta Biomaterialia Surface Science, Applied Surface Science, Corrosion science itd. / Targeted selection and discussion of scientific publications, particularly from Science, Nature, Scientific reports, Nature Materials, Acta Metallurgica, Acta Biomaterialia Surface Science, Applied Surface Science, Corrosion science.

Cilji in kompetence:

Cilj predmeta je usposobiti študenta za razumevanje teoretičnega in praktičnega znanja o karakterizaciji sodobnih kovinskih materialov, biomaterialih in inženirskih materialov, nanomaterialov. Sposobnost za poznavanje in razumevanje lastnosti kovinskih materialov, povezanih s strukturo (mehanske lastnosti, mikrostruktura, mikrotekstura, analizna kemija).

Cilj se navezuje na kompetence:

- obvladovanje metod in tehnik znanstvenega raziskovanja
- sposobnost za samostojno in skupinsko raziskovalno in razvojno delo
- sposobnost uporabe znanja v praksi in
- delno tudi razvoj integralnega načina

Objectives and competences:

The objective of the course is to train a student to understand basics of the characterization of advanced metallic materials, biomaterials and engineering materials, properties of metallic materials and their structures (mechanical properties, microstructure, micro texture; chemical analytical chemistry)

This objective is related to competences:

- mastering of methods and techniques of scientific research ability to carry out independent as well as team R&D work,
- ability to use the knowledge in practice,
- and partially also to the development of an integral way of thinking and the ability to communicate with experts from other disciplines

mišljenja ter sposobnost za komunikacijo s strokovnjaki drugih disciplin in področij

and fields.

Predvideni študijski rezultati:

- Poznati in razumeti mehanske lastnosti in preizkušanje kovinskih materialov
- Poznati in razumeti teoretične in praktične osnove določevanja mehanskih lastnosti kovinskih materialov in specifičnosti nekaterih numeričnih metod in modeliranja.
- Poznati osnove rasti ultra tankih in tankih plasti z vsemi oblikami naprševanja na kovine in zlitine ter s pomočjo plazemskih tehnologij, inženiring materialov s pomočjo obvladovanja mikrokemije kovinskih materialov, razvoja oziroma krojenja mikro-strukture in posredno lastnosti kovinskih materialov.
- Poznati in znati uporabiti teoretično in praktično znanje o metodah za karakterizacijo tankih in ultra tankih plasti ter nano in mikrostrukture ter mikro teksture ter osnovno znanje o analitskih metodah za določanje kemijske sestave kovinskih materialov.

Intended learning outcomes:

- Know and understand the basics of the mechanics and testing of metallic materials
- Know and understand practical determination of mechanical properties and gain some specificity of numerical methods and modeling
- Know and understand the thin film growth by all forms of sputter deposition, plasma techniques, and materials engineering in order to control and tailor microchemistry, microstructure, and, hence, physical properties of metals and alloys
- Know and apply the analytical techniques for characterization of thin and ultra-thin films, and nano and microstructure and analytical methods for chemical analysis of metallic materials

Metode poučevanja in učenja:

Uvodna predstavitev.
Seminarsko skupinsko delo.
Vključevanje v projekte za razvoj sposobnosti uporabe opreme.
Uporaba raziskovalne opreme v reševanju izbranega problema, analiza rezultatov, priprava seminarske predstavitve.

Learning and teaching methods:

Introductory presentation.
Seminar team work.
Participation in projects for the development of ability to use research equipment.
Solving selected problem with research equipment, analysis of results, preparation of the seminar presentation.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Seminarska naloga.	50 %	Seminar work.
Zagovor seminarske naloge, pri katerem dokaže osvojitve vseh študijskih izidov z vsaj po enim konkretnim primerom.	50 %	Defense of the seminar work where the student demonstrates the achievement of all learning outcomes with at least one specific case for each outcome.

Izbrane reference nosilca / Lecturer's selected references:

- JENKO, Monika, GORENŠEK, Matevž, GODEC, Matjaž, HODNIK, Maxinne, ŠETINA, Barbara, DONIK, Črtomir, GRANT, John T., DOLINAR, Drago. Surface chemistry and microstructure of metallic biomaterials for hip and knee endoprostheses. Applied Surface Science, ISSN 0169-4332. [Print ed.], Avg. 2017, vol. 427, str. 584-593, ilustr.
<http://www.sciencedirect.com/science/article/pii/S0169433217323206>, doi: 10.1016/j.apsusc.2017.08.007. [COBISS.SI-ID 1331882],
- PUKŠIČ, Nuša, JENKO, Monika, GODEC, Matjaž, MCGUINNESS, Paul J. A comparison of the uniaxial deformation of copper and nickel (1 1 19) surfaces: a molecular dynamics study. Scientific reports, ISSN

2045-2322, Feb. 2017, vol. 7, str. 1-7, ilustr.

http://www.nature.com/articles/srep42234?WT.feed_name=subjects_physics, doi:

[10.1038/srep42234](https://doi.org/10.1038/srep42234). [COBISS.SI-ID [1283498](#)],

- GERVASONI, J. L., JENKO, Monika, PONIKU, Besnik, BELIČ, Igor, JUAN, A. Effects of the electron-hole pair in Auger and X-ray photoemission spectroscopy from surfaces of Fe-Si. *Nuclear instruments & methods in physics research. Section B, Beam interactions with materials and atoms*, ISSN 0168-583X. [Print ed.], 2015, vol. 354, str. 313-316, ilustr.

<http://www.sciencedirect.com/science/article/pii/S0168583X1500035X>, doi:

[doi:10.1016/j.nimb.2015.01.022](https://doi.org/10.1016/j.nimb.2015.01.022). [COBISS.SI-ID [1111466](#)]

- JOKANOVIĆ, Vukoman, VILOTIJEVIĆ, Miroljub, ČOLOVIĆ, B., JENKO, Monika, ANŽEL, Ivan, RUDOLF, Rebeka. Enhanced adhesion properties, structure and sintering mechanism of hydroxyapatite coatings obtained by plasma jet deposition. *Plasma chemistry and plasma processing*, ISSN 0272-4324. [Print ed.], Jan. 2015, vol. 35, iss. 1, str. 1-19. <http://link.springer.com/article/10.1007%2Fs11090-014-9599-0>, doi: [10.1007/s11090-014-9599-0](https://doi.org/10.1007/s11090-014-9599-0). [COBISS.SI-ID [18312214](#)],

- CARDOSO SCHWINDT, V., ARDENGHI, J. S., ŠETINA, Barbara, BECHTHOLD, P., GONZÁLEZ, E. A., JASEN, P. V., JUAN, A., JENKO, Monika. Selenium adsorption at different coverages on Fe(1 0 0) and Fe(1 1 1) : a DFT study. *Applied Surface Science*, ISSN 0169-4332. [Print ed.], Oct. 2014, vol. 315, str. 252-260, ilustr. <http://www.sciencedirect.com/science/article/pii/S0169433214016596>, doi:

[10.1016/j.apsusc.2014.07.131](https://doi.org/10.1016/j.apsusc.2014.07.131). [COBISS.SI-ID [1062826](#)]