

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Uvod v okolju prijazne plazemske tehnologije
Course title:	Introduction to Environmentally Friendly Plasma Technologies

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Ekotehnologije, 3. stopnja		1	1
Ecotechnologies, 3 rd cycle		1	1

Vrsta predmeta / Course type Izbirni / Elective

Univerzitetna koda predmeta / University course code: EKO3-363

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. Miran Mozetič

Jeziki / Languages:	Predavanja / Lectures:	slovenščina, angleščina Slovenian, English
	Vaje / Tutorial:	slovenščina, angleščina Slovenian, English

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

Znanje, ki je ekvivalentno izobrazbi druge stopnje ali univerzitetni izobrazbi s področja naravoslovja ali tehnologije.

Prerequisites:

Knowledge, which is equivalent to a second level or university degree from natural sciences or technology.

Vsebina:

- Neravnovesno stanje plina in plinske razelektritve (enosmerna, nizkofrekvenčna, radiofrekvenčna, mikrovalovna razelektritev, kombinirane razelektritve).
- Plazma (nastanek plazme, osnovne značilnosti in parametri plazme, ionske in reaktivne plazme, metode za plazemsko diagnostiko, plazemski reaktorji).
- Plazemske tehnologije (interakcija plazemskih radikalov s površinami trdnin, pregled vakuumskih plazemskih tehnologij, plazemska aktivacija in pasivizacija površin, plazemsko čiščenje, hladno upepeljevanje, plazemska

Content (Syllabus outline):

- Non-equilibrium state of gas and gaseous discharge (DC discharge, low-frequency discharge, radiofrequency discharge, microwave discharge, combined discharges).
- Plasma (plasma formation, basic characteristics and parameters of plasma, ionic and reactive plasmas, methods of plasma diagnostics, plasma reactors).
- Plasma technologies (interaction of plasma radicals with surface of solids, overview of vacuum plasma technologies, plasma surface activation and passivation, plasma cleaning, cold incineration, plasma functionalization and

funkcionalizacija in biokompatibilni materiali, selektivno plazemsko jedkanje, plazemska sterilizacija).

- Plazma v industriji (posnetek stanja in trendi, mikroelektronika, elektroindustrija, kemična industrija, avtomobilska industrija, biologija in medicina).
- Komerčni vidiki plazemskih tehnologij (ocena materialne, kadrovske in časovne zahtevnosti plazemskih tehnologij, plazemske tehnologije in ekologija, varno delo s plazemskimi napravami).

biocompatible materials, selective plasma etching, plasma sterilization).

- Plasma in industry (current state and trends, microelectronics, electrical industry, chemical industry, automobile industry, biology and medicine).
- Commercial aspects of plasma technologies (assessment of complexity of plasma technologies in terms of costs, staff and time, plasma technologies and ecology, safety at work with plasma equipment).

Temeljni literatura in viri / Readings:

Knjige/Books

- Marija Gorjanc, Miran Mozetič, Modification of fibrous polymers by gaseous plasma: principles, techniques and applications. Saarbrücken: LAP Lambert Academic Publishing, 2014, ISBN 978-3-659-61460-6.
- Rajdeep Singh Rawat, Plasma Science and Technology for Emerging Economies, Springer, Berlin, 2017, ISBN 978-981-10-4217-1.
- Chang-Ming Du, Jian-Hua Yan, Plasma Remediation Technology for Environmental Protection, Springer, Berlin, 2017, ISBN 978-981-10-3656-9.

Revije/Journals:

- Plasma Sources Science and Technology
- Plasma Processing and Polymers
- Plasma Chemistry and Plasma Processing
- Plasma
- Surface and Coatings Technology
- Applied Surface Science

Cilji in kompetence:

Študentje pridobijo osnovna znanja s področja plazemskih tehnologij ter dobijo pregled nad razpoložljivo opremo:

- naučijo se kritično oceniti pomanjkljivosti klasičnih tehnoloških postopkov za obdelavo materialov, predvsem z vidika kakovosti in ekološke (ne)ustreznosti tehnologij,
- pridobijo znanja, ki so potrebna za samostojno pripravo elaborata, v katerem ocenijo možnosti zamenjave obstoječih klasičnih tehnologij z novimi plazemskimi tehnologijami,
- naučijo se kritično oceniti prednosti in pomanjkljivosti plazemskih tehnologij, predvsem časovno, kadrovske in finančne zahtevnost vpeljave novih tehnologij, ekološke prednosti novih tehnologij in kakovosti novih tehnologij.

Objectives and competences:

The students master the basic skills in the domain of plasma technologies and gain an overview of available equipment:

- critically assess deficiencies of conventional technological procedures for processing materials, in particular from the viewpoint of quality and ecological (un)acceptability of technologies,
- obtain knowledge required to independently prepare a study in which the possibilities of replacement of the existing conventional technologies by new plasma ones are assessed,
- learn to critically evaluate the advantages and deficiencies of plasma technologies, in particular the complexity of introduction of new technologies in terms of time, staff and funding, their ecological advantages and their quality.

<p>Kompetence:</p> <ul style="list-style-type: none"> • presoditi prednosti neravnovesnih plazemskih tehnologij, • ugotoviti možnosti zamenjave klasičnih postopkov s plazemskimi, • oceniti ustreznost plinskih razelektritev za vzbujanje plazme, • izbrati primerne plazemske parametre za procesiranje materialov, • izmeriti osnovne plazemske parametre, • oceniti finančne vidike izbrane plazemske tehnologije, • oceniti okoljske vidike plazemske tehnologije.
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<p>Competences:</p> <ul style="list-style-type: none"> • judging about advantages of plasma technologies, • finding possibilities for replacing classical technologies with plasma techniques, • evaluate suitability of gaseous discharges for plasma generation, • selecting feasible plasma parameters for processing materials, • measuring basic plasma parameters, • estimating economic aspects of selected plasma technology, • estimating environmental aspects of plasma technology.
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Predvideni študijski rezultati:

<p>Študenti bodo z uspešno opravljenimi obveznostmi tega predmeta pridobili sposobnosti:</p> <ul style="list-style-type: none"> • presoditi možnosti uporabe plazemske tehnologije za procesiranje materialov, • izbrati primeren plazemski reaktor za obdelavo izbranega materiala, • izmeriti osnovne plazemske parametre, • priporočati industriji plazemske tehnologije, • razlikovati med plinsko plazmo in neravnovesnimi stanji plinov, • zgraditi eksperimentalni plazemski reaktor za obdelavo vzorcev, • sklepati o ekonomski upravičenosti plazemskih tehnologij.

Intended learning outcomes:

<p>Students successfully completing this course will acquire abilities to:</p> <ul style="list-style-type: none"> • estimate possibilities of plasma technologies for materials processing, • select the appropriate plasma reactor for specific material; • measure basic plasma parameters, • recommend plasma technology to industry, • distinguish between plasma and non-equilibrium state of gas, • construct an experimental reactor for treatment of samples, • evaluate the economic aspects of plasma technology.
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Metode poučevanja in učenja:

<ul style="list-style-type: none"> • Kratka predavanja • Seminar • Laboratorijsko delo

Learning and teaching methods:

<ul style="list-style-type: none"> • Short courses • Seminar • Laboratory work

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
<ul style="list-style-type: none"> • Ocena laboratorijskega dela oziroma eksperimentalnih spretnosti 	20 %	<ul style="list-style-type: none"> • Experimental skills and ability for working in a laboratory
<ul style="list-style-type: none"> • Seminarska naloga 	40 %	<ul style="list-style-type: none"> • Seminar
<ul style="list-style-type: none"> • Usten zagovor seminarske naloge 	40 %	<ul style="list-style-type: none"> • Oral justification of the seminar

Reference nosilca / Lecturer's references:

<p>280 scientific papers, 20 patents granted, 4500 citations, H-index 37.</p> <ul style="list-style-type: none"> • VANRENTERGHEM, Bart, HODNIK, Nejc, BELE, Marjan, ŠALA, Martin, AMELINCKX, Giovanni, NEUKERMANS, Sander, ZAPLOTNIK, Rok, PRIMC, Gregor, MOZETIČ, Miran, BREUGELMANS, Tom. Increase of electrodeposited catalyst stability via plasma grown vertically oriented graphene nanoparticle movement restriction. Chemical communications, ISSN 1359-7345, 28 Aug. 2017, vol. 53, iss. 67, str. 9340-9343, ilustr. http://pubs.rsc.org/en/content/articlepdf/2017/cc/c7cc05828d, doi: 10.1039/c7cc05828d.
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- SUNNY, Anu Tresa, MOZETIČ, Miran, PRIMC, Gregor, MATHEW, Suresh, THOMAS, Sabu. Tunable morphology and hydrophilicity to epoxy resin from copper oxide nanoparticles. *Composites science and technology*, ISSN 0266-3538. [Print ed.], 2017, vol. 146, str. 34-41, doi: 10.1016/j.compscitech.2017.04.010.
- HOLC, Matej, JUNKAR, Ita, PRIMC, Gregor, ISKRA, Jernej, TITAN, Primož, GROBELNIK MLAKAR, Silva, KOVAČ, Janez, MOZETIČ, Miran. Improved sprout emergence of garlic cloves by plasma treatment. *Plasma medicine*, ISSN 1947-5764, 2017, vol. 6, no. 3/4, str. 325-338, doi: 10.1615/PlasmaMed.2016019133.
- DRAŠKOVIČ-BRAČUN, Aljaž, MOZETIČ, Miran, ZAPLOTNIK, Rok. E- and H-mode transition in a low pressure inductively coupled ammonia plasma. *Plasma processes and polymers*, ISSN 1612-8869, [in press] 2017, 10 str., doi: 10.1002/ppap.201700105.
- PRAVEEN, K. M., THOMAS, Sabu, GROHENS, Yves, MOZETIČ, Miran, JUNKAR, Ita, PRIMC, Gregor, GORJANC, Marija. Investigations of plasma induced effects on the surface properties of lignocellulosic natural coir fibres. *Applied Surface Science*, ISSN 0169-4332. [Print ed.], 2016, vol. 368, str. 146-156, doi: 10.1016/j.apsusc.2016.01.159.