UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Napredne obdelave materialov
Course title:	Advanced Processing of Materials

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

Vrsta predmeta / Course type Izbirni / Elective

Univerzitetna koda predmeta / University course code: EKO3-776

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 transfered to individual work.*

Nosilec predmeta / Lecturer: Prof. dr. Uroš Cvelbar
Prof. dr. James Walsh

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Zaključen študij druge stopnje naravoslovne ali tehniške smeri ali zaključen študij drugih smeri z dokazanim poznavanjem osnov področja predmeta (pisna dokazila, pogovor).	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:	**Content (Syllabus outline):**
• Pregled procesnih plazem • Nizkotlačne in atmosferske plazme • Uporaba plazem v industrijskih procesih za obdelavo materialov • Plazemska aktivacija površin • Selektivno plazemsko jedkanje materialov • Nano-strukturiranje površin • Plazemska sinteza (nano)materialov • Hladno upepeljevanje	• Overview of processing plasmas • Low-pressure versus atmospheric pressure plasmas • Application of plasmas into industrial processes for material treatment • Plasma surface activation • Selective etching of materials • Nanostructuring surfaces • Plasma synthesis of (nano)materials

• Razgradnja toksičnih materialov • Dekontaminacija površin • Nanosi nanomaterialov na površine • Študije primerov uporabe (Polimerni kompoziti in tehnologije za njihovo obdelavo, ipd.)	• Cold ashing • Degradation of toxic materials • Decontamination of surfaces • Depositions of nanomaterials • Case studies (Polymer composites and technologies for their treatments)

Temeljni literatura in viri / Readings:

- F.F. Chen, J.P. Chang: Lecture Notes on Principles of Plasma Processing, Springer, 2013.
- M.A. Lieberman, A.J. Lichtenberg: Principles of Plasma Discharges and Material Processing, John Wiley and Sons, 2005.
- M. Sankaran (ed): Plasma Processing of Nanomaterials, CRC, 2011.
- H. Rauscher, M. Perucca, G. Buyle (ed): Plasma Technologies for Hyperfunctional Surfaces: Food, Biomedical and Textile Applications, Wiley-VCH, 2010.
- J. Friedrich: The Plasma Chemistry of Polymer Surfaces: Advanced Techniques for Surface Design, Wiley, 2012.

Ciljani izbor in razprava o aktualnih znanstvenih objavah, predvsem v uglednih revijah / Targeted selection and discussion of scientific publications, particularly distinguished journals.

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je seznanitev študentov z naprednimi obdelavami materialov, ki temeljijo predvsem na uporabi termodinamsko neravnovesnih stanj plinov oz. plazemskih obdelavah. Te obdelave so namreč ekološko neoporečne, omogočajo pa spremembe ali sinteze materialov na atomarnem nivoju gradnik-po-gradnik. Med procesnimi plazmami so se uveljavile predvsem nizkotlačne in atmosferske plazme, ki so primerne tudi za široko industrijsko uporabo. Pri predmetu študenti spoznajo osnovne interakcije plazme z materiali in procese, ki vodijo do njihove aktivacije, selektivnega jedkanja, hladnega upepeljevanja, nanostrukturiranja ali sinteze novih materialov. Spoznajo tudi plazemske procese za razgradnje toksičnih substanc in materialov ter dekontaminacije površin. Predavanja vsebujejo tudi prikaz nekaterih tehnoloških rešitev v industriji, kar omogoča študentom kritično oceno uporabnosti novih procesnih tehnologij za materiale v praksi. Cilj se navezuje na kompetence: • obvladovanje metod in tehnik, • sposobnost za samostojno in skupinsko raziskovalno in razvojno delo, • sposobnost uporabe znanja v praksi in	The objective of this course is to introduce students with advanced processing of materials, which are based mostly on use of thermodynamically non-equilibrium states of gas called plasma processing. The major benefits of this processing are ecological advantages and modifications or synthesis of materials on atomic scale atom-by-atom. The most useful plasmas for industrial environment are low or atmospheric pressure processing plasmas. Within this course, students gain knowledge on principles of plasma-surface interactions and material processing, which leads to surface activation, selective etching, cold ashing, surface nanostructuring and synthesis of new materials. Students become familiar with plasma processes for degradation of toxic materials and decontamination of surfaces. The lectures include the case studies of technological solutions for industrial applications, which enable students' critical assessment of applicability of processing technologies for materials in practice. This objective is related to competences: • mastering of methods and techniques of sensor technologies, • ability to carry out independent as well as team R&D work, • ability to use the knowledge in practice,

• delno tudi razvoj integralnega načina mišljenja ter sposobnost za komunikacijo s strokovnjaki drugih disciplin in področij.	• and partially also to the development of an integral way of thinking and the ability to communicate with experts from other disciplines and fields.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Študent bo na osnovi pridobljenega znanja: • razumel lastnosti posameznih plazem in procesov, ki potekajo ob interakciji plazme z materiali; • izbral pravilne parametre plazme pri uporabi v procesih, s katerimi lahko izboljšamo različne lastnosti površin materialov, sintetiziramo nove materiale ali jih razgradimo; • izbral primerno okolju prijazno in učinkovito tehnoloških rešitev za obdelavo materialov; • razumel fizikalne in kemijske postopke, ki potekajo v teh procesih; • spoznal ekonomske vidike za uporabo teh tehnoloških postopkov v industrijskem okolju; • vzpostavil sposobnost komunikacije v angleškem jeziku na področju materialov in tehnologije za njihovo obdelavo.	The student will: • understand the plasma properties and processes, which occur during plasma material processing; • select proper plasma and its parameters for processing, which will further improve material surface properties, enable synthesis of new materials or cause their decomposition; • select a proper advanced environmentally friendly technological procedures for material processing; • understand underlying physical and chemical mechanisms of these processes; • learn about the commercial perspectives of the implementation of these technological procedures into industrial environment; • establish the ability to communicate in English in the field of materials and technologies for their treatment.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Interaktivna predavanja Seminar Delo v laboratoriju Konzultacije	Interactive lectures Seminar Work in laboratory Consultations

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

Reference nosilca / Lecturer's references:

CVELBAR, Uroš, CANAL, Cristina, HORI, Masaru. Plasma-inspired biomaterials : editorial. *Journal of physics. D, Applied physics*, ISSN 0022-3727, 2017, vol. 50, no. 4, str. 040201-1-040201-4, doi: 10.1088/1361-6463/50/4/040201. [COBISS.SI-ID 30115367]

PULIYALIL, Harinarayanan, FILIPIČ, Gregor, **CVELBAR, Uroš.** Recent advances in the methods for designing superhydrophobic surfaces. V: SALIH, Mohammed Salih (ur.). *Surface energy*. Rijeka: InTech. cop. 2015, str. 311-335. [COBISS.SI-ID 29233959]

THOMAS, Sabu (urednik), **CVELBAR, Uroš** (urednik). *Micro- and nano-structured interpenetrating polymer networks : from design to applications*. Hoboken: Wiley, 2016. XVI, 406 str., ilustr., graf. prikazi. ISBN 978-1-118-13817-5. [COBISS.SI-ID 29456167]

BARANOV, Oleg B., BAZAKA, K., KERSTEN, Heinrich, KEIDAR, Michael, **CVELBAR, Uroš**, XU, S. F., LEVCHENKO, Igor. Plasma under control : advanced solutions and perspectives for plasma flux management in material treatment and nanosynthesis. *Applied physics reviews*, ISSN 1931-9401, 2017, vol. 4, no. 4, str. 041302-1-041302-33, doi: 10.1063/1.5007869. [COBISS.SI-ID 31010599]

HOJNIK, Nataša, **CVELBAR, Uroš,** TAVČAR-KALCHER, Gabrijela, WALSH, James L., KRIŽAJ, Igor. Mycotoxin decontamination of food : cold atmospheric pressure plasma versus "classic" decontamination. *Toxins : Elektronski vir*, ISSN 2072-6651, 2017, vol. 9, no. 5, str. 151-1-151-19, doi: 10.3390/toxins9050151. [COBISS.SI-ID 30460967]