Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Nanotehnologija v okolju**
Course title:	**Nanotechnology in the Environment**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Ekologija z naravovarstvom / 1. stopnja	**/**	**2. in 3.; 2nd and 3rd**	**4. ali 5. ali 6.; 4th or 5th or 6th**
Ecology with Nature Conservation / 1. level	**/**		

Vrsta predmeta / Course type	Izbirni/Elective
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	**15**				**135**	**180/6**

Nosilec predmeta / Lecturer:	**Sebastijan Kovačič**

Jeziki / Languages:	**Predavanja / Lectures:**	**Slovenski/Slovene**
	Vaje / Tutorial:	

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Pisni izpit kot oblika obveznosti omenjena v načinih ocenjevanja mora biti opravljena s pozitivno oceno. Opravljena seminarska naloga je pogoj za pristop k pisnemu izpitu.	The written examination must be assessed with a passing grade. A completed seminar is a prerequisite for participation in the written examination.

Vsebina: **Content (Syllabus outline):**

1. Uvod v nanoznanost - Definicija ˝nano˝, znanstvena revolucija - atomska velikost - Vpliv ˝nano˝ na mikro / makro – efekt velikosti - Razmerje med površino in prostornino – učinek specifične površine na lastnosti - Vrste nanostruktur in lastnosti nanomaterialov: Enodimenzionalni (1D), dvodimenzionalni (2D) in tridimenzionalni (3D) nanostrukturirani materiali - Nanomateriali: Priprava, izdelava in karakterizacija 2. Aplikacija nanotehnologije za sanacijo okolja - Razvoj na področju nanoporoznih organskih materialov za sanacijo okolja - Uporaba nanodelcev v postopkih sanacije tal in vode - Fotokatalitsko čiščenje in sanacija zraka in vode - Ogljikovi nanomateriali za okoljske namene 3. Nanotehnologija pri pretvorbi in skladiščenju energije - Uvod v fotofiziko polprevodnikov - Prevodni in polprevodniški materiali - Organske solarne celice - Organsko-anorganske hibridne solarne celice 4. Uvod v Nanotoksikologijo - Toksičnost nanodelcev: vrste nanodelcev in mehanizmi toksičnosti - Genotoksičnost različnih nanodelcev: SiO_2, TiO_2, Au, Ag, CNT 5. Seminar - podrobna vsebina seminarja se bo določila na osnovi dogovora z mentorjem in se bo nanašala na pregled literature (za zadnjih pet let) v zvezi z aplikacijami specifičnega materiala.	1. Introduction to Nanoscience - Definition of ˝Nano˝, Scientific revolution-atomic size, - Influence of nano over micro/macro – size effects. - Relationship surface versus volume ratio – the effect of a specific surface area on the properties - Types of nanostructures and properties of nanomaterials: One dimensional (1D), Two dimensional (2D) and Three dimensional (3D) nanostructured materials, - Nanomaterials: Preparation, Fabrication, and Characterization 2. Nanotechnology for Environmental Remediation - Recent advances in nanoporous organic materials for environmental remediation applications - The Use of Nanoparticles in Soil and Water Remediation Processes - Photocatalytic purification and remediation of contaminated air and water - Carbon Nanomaterials for Environmental Applications 3. Nanotechnology in Energy Conversion and Storage - Introduction to the semiconductor photophysics - Conducting and semiconducting materials - Organic solar cells - Organic-inorganic hybrid solar cells 4. Introduction to Nanotoxicology - The Toxicity of Nanoparticles: An overview of nanoparticles and mechanisms of action - Genotoxicity of different nanoparticles: SiO_2, TiO_2, Au, Ag, CNT 5. Seminar - Detailed content of a seminar will be determined on the basis of agreement with the mentor and will be related to a literature survey (in recent five years) regarding applications of particular material

Temeljni literatura in viri / Readings:

- Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim , 2004.
- Conducting polymers with micro or nano meter structure, Meixiang Wan, Springer, 2008.
- Organic Photovoltaics – Materials, Device Physics and Manufacturing Technologies, (eds. C. Brabec, V. Dyakonov, U. Scherf), 2nd Ed., Wiley-VCH, Germany, 2014.

Cilji in kompetence:	**Objectives and competences:**
- Razložiti strukturne vplive nanodimenzioniranih materialov na reaktivnost in remediacijsko učinkovitost - Obvladovanje različnih postopkov čiščenja in vpliv nanodimenzioniranih materialov na zdravje človeka	- To explain the structural effects of nano dimensional materials on reactivity and remediation efficiency - Mastering different purification procedures and the impact of nanostructured materials on human health

Predvideni študijski rezultati:

Intended learning outcomes:

Znanje in razumevanje: - Ovrednoti prednosti in slabosti nanotehnologije za čiščenje okolja - Pojasni oblikovanja materialov na atomski in molekularni ravni - Navede tveganja uporabe nanomaterialov - Našteje tehnologije za shranjevanje energije - Kritična ocena stanja onesnaženosti okolja in poznavanje aktualnih tehnologij za čiščenje okolja.	Knowledge and understanding: - Evaluate the advantages and disadvantages of using nanotechnology in the environment remediation - Explain the shaping and combining matter at the atomic and molecular scale - Specify the risks of using nanomaterials - List diverse energy storage systems - A critical assessment of the current state-of-the-art of environmental pollution and available technologies for remediation

Metode poučevanja in učenja:	**Learning and teaching methods:**
- Predavanja - Od študenta se pričakuje, da bo naredil pregled literature (za zadnjih pet let) na dodeljeni temi v zvezi z aplikacijami mikroporoznega materiala in izdelal seminarsko nalogo (10-strani), katero bo kasneje tudi predstavil (ppt). Povzetek predstavitve in seminarska naloga morata biti poslana teden dni pred datumom predstavitve.	- Lectures - Students enrolled in this course will be expected to do a literature survey (in recent five years) on an assigned topic regarding applications of particular microporous material and write a seminar work (10-page and double-space) followed by presentation for the literature review. The title and abstract of the presentation should be emailed a week before the date of presentation, and a copy of the presentation slides together with the seminar work.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Izdelki: Seminarska naloga	20%	Outputs: Seminar paper
Znanje: Pisni izpit	80%	Knowledge: Written exam

Reference nosilca / Lecturer's references:

- VRTOVEC, Nika, JURJEVEC, Sarah, ZABUKOVEC LOGAR, Nataša, MAZAJ, Matjaž, KOVAČIČ, Sebastijan. Metal oxide-derived MOF-74 polymer composites through pickering emulsion-templating: interfacial recrystallization, hierarchical architectures, and CO2 capture performances. ACS applied materials & interfaces. 2023, 15, 18354-18361BALLAI, Gergő, KOTNIK, Tomaž, FINŠGAR, Matjaž, PINTAR, Albin, KÓNYA, Zoltán, SÁPI, András, KOVAČIČ, Sebastijan. Highly porous polymer beads coated with nanometer-thick metal oxide films for photocatalytic oxidation of bisphenol A. ACS applied nano materials. 2023, 6, 20089–20098.
- KOVAČIČ, Sebastijan, SCHAFZAHL, Bettina, MATSKO, Nadejda B., GRUBER, Katharina, SCHMUCK, Martin, KOLLER, Stefan, FREUNBERGER, Stefan A., SLUGOVC, Christian. Carbon foams via ring-opening metathesis polymerization of emulsion templates : a facile method to make carbon current collectors for battery applications. ACS applied energy materials. 2022, 5, 14381-14390
- MAZAJ, Matjaž, ZABUKOVEC LOGAR, Nataša, ŽAGAR, Ema, KOVAČIČ, Sebastijan. A facile strategy towards highly accessible and hydrostable MOF-phase within the hybrid polyHIPEs

through in-situ metal-oxide recrystallization. *Journal of Materials Chemistry. A*, Materials for energy and sustainability, **2017**, 5, 1967-1971

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