

**UČNI NAČRT PREDMETA / COURSE SYLLABUS**

**Predmet:** NANOMATERIALI IN KOMPOZITI  
**Course Title:** NANOMATERIALS AND COMPOSITES

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
MAG Kemijsko inženirstvo, 2. stopnja	/	1.	1.
USP Chemical Engineering, 2 <sup>nd</sup> Cycle	/	1 <sup>st</sup>	1 <sup>st</sup>

**Vrsta predmeta / Course Type:**

obvezni / Mandatory

**Univerzitetna koda predmeta / University Course Code:**

IN212

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
45	30	/	/	/	75	5

**Nosilec predmeta / Lecturer:**

prof. dr. Marjan Marinšek / Dr. Marjan Marinšek, Associate Professor  
prof. dr. Urška Šebenik / Dr. Urška Šebenik, Full Professor

**Jeziki / Languages:**

**Predavanja / Lectures:** slovenski / Slovenian

**Vaje / Tutorial:** slovenski / Slovenian

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

Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.

**Prerequisites:**

The course has to be assigned to the student.

**Vsebina:**

- Definicija nanotehnologije, nanomateriala, nanostrukturiranega materiala, kompozita, nanokompozita;
- Osnovne značilnosti nanomaterialov in nano efekt: površinski in kvantni prispevek,
- Strukturne značilnosti nanodelcev, samoorganiziranje gradnikov v klastre, nanodelce, enoslojne in večslojne cevke, paličice in žičke, tanke filme;
- Sinteza nanomaterialov;
- Sinteza/priprava nanokompozitov in nanostrukturiranih materialov;

**Content (Syllabus outline):**

- Definition of nanotechnologies, nanomaterials, nanostructured materials, composites, nanocomposites;
- Basic characteristics of nanomaterials: surface and quantum effects;
- Structural characteristics of nanoparticles, self assembly of clusters, nanoparticles, single and multiple-walled nanotubes, nanorods and nanowires, thin films;
- Synthesis of nanomaterials;
- Synthesis/preparation of nanocomposites and nanostructured materials;

- Odvisnost lastnosti nanostrukturiranih materialov in nanokompozitov od njihove strukture in drugih karakteristik;
- Polimerni nanokompoziti (polimerne zmesi, polimer/nanopolnilo) in primerjava s klasičnimi polimernimi kompoziti;
- Sodobne karakterizacijske tehnike za nanostrukturirana materiale in nanokompozite;
- Uporaba nanostrukturiranih materialov in nanokompozitov.

- Dependence of nanomaterials and nanocomposites properties on their structure and other characteristics;
- Polymer nanocomposites (polymer blends and polymer/nanofiller composites) and comparison with classical polymer composites;
- Modern characterization techniques for nanomaterials and nanocomposites;
- Uses of nanostructured materials and nanocomposites.

### Temeljna literatura in viri / Readings:

- M. Kuno, Introductory nanoscience, Garland Science, Taylor & Francis Group, LCC, New York, 2012, 447 str. (40 %)
- M. Hosokawa, K. Nogi, M. Naito, T. Yokoyama, Nanoparticle technology handbook, Elsevier, Amsterdam, 2012, 703 str. (20 %)
- K. Friedrich, S. Fakirov, Z. Zhang, Polymer composites : from nano-to-macro-scale. Springer, New York, 2005, 341 str. (50 %).

#### Dopolnilna literatura:

- D. R. Paul, L. M. Robeson, Polymer nanotechnology: Nanocomposites. Polymer, 2008, 49(15), 3187-3204 str.
- J. H. Koo, Polymer nanocomposites: processing, characterization, and applications. McGraw-Hill Professional, New York, 2006, 261 str.

### Cilji in kompetence:

Cilj predmeta je, da študentje osvojijo osnovna znanja o novih, naprednih materialih, ki v zadnjem desetletju predstavljajo revolucijo in perspektivo na področju znanosti o materialih.

Študentje pri predmetu pridobijo naslednje specifične kompetence:

- poznavanje definicije nanomaterialov, nanokompozitov in nanostrukturiranih materialov;
- poznavanje osnovnih vrst nanostrukturiranih materialov,
- poznavanje metod in procesov za pripravo vseh vrst nano materialov,
- poznavanje karakterizacije nano materialov,
- poznavanje možnosti tehnoloških aplikacij vseh vrst nano materialov.

### Objectives and Competences:

Acquiring the knowledge and ability for further studies and research of nanomaterials, relating the basic differences of these materials to bulk materials to the size and quantum effects, knowing basic methods and processes for their preparation and characterization, foreseeing possible use of such materials.

Acquiring fundamental knowledge about nanomaterials and nanocomposites which represent a revolution and open new perspectives in the field of material science.

### Predvideni študijski rezultati:

### Intended Learning Outcomes:

<p><u>Znanje in razumevanje</u> Študent bo znanja s področja klasičnih materialov razširil na nanopodročje, tj. nanomateriale, nanokompozite, nanostrukturirane materiale. Razumel bo izvor nano-efekta pri nanomaterialih.</p>	<p><u>Knowledge and Comprehension</u> Extension of knowledge in the area of materials with knowledge specific to nanomaterials, nanocomposites and nanostructured materials. Understanding the nanoeffect.</p>
<p><u>Uporaba</u> Specifične lastnosti nanomaterialov, nanokompozitov in nanostrukturiranih materialov bo analiziral glede na potencialne možnosti za njihovo uporabo in pri pri načrtovanju novih materialov.</p>	<p><u>Application</u> Designing novel, advanced nanomaterials, nanocomposites and nanostructured materials for specific applications.</p>
<p><u>Refleksija</u> Študent bo specifična znanja o nanomaterialih koreliral s klasičnimi materiali, tako glede njihovih osnovnih lastnosti kot tudi metod oziroma procesov za njihovo pripravo ter uporabo.</p>	<p><u>Analysis</u> Correlation and comparison of specific properties of nanomaterials and nanocomposites with properties, preparation methods and applications of classic materials and composites.</p>
<p><u>Prenosljive spretnosti</u> Iskanje domače in tuje literature iz različnih virov, zbiranje, obdelava in interpretacija podatkov, analiza in sinteza rezultatov, pisanje člankov ipd.</p>	<p><u>Skill-transference Ability</u> Literature research; Literature data collecting, analysis and interpretation; Results analysis and interpretation; Project work presentation.</p>

**Metode poučevanja in učenja:**

Predavanja, seminarji in projektno delo.

**Learning and Teaching Methods:**

Lectures, seminars, project.

**Načini ocenjevanja:**

Pisni in ustni izpit.  
Opravljena seminarska naloga je pogoj za pristop k izpitu.

Delež (v %) /

Weight (in %) **Assessment:**

Written and oral exam.  
Accomplished project work is a prerequisite to exam attendance.

**Reference nosilca / Lecturer's references:**

- **MARINŠEK, Marjan**, ŠALA, Martin, JANČAR, Boštjan. A study towards superior carbon nanotubes-supported Pd-based catalysts for formic acid electro-oxidation : preparation, properties and characterisation. *Journal of power sources*, ISSN 0378-7753, 2013, vol. 235, no. 1, str. 111-116
- **MARINŠEK, Marjan**, ZUPAN, Klementina. Microstructure evaluation of sintered combustion-derived fine powder NiO-YSZ. *Ceramics international*, ISSN 0272-8842. [Print ed.], 2010, vol. 36, no. 3, str. 1075-1082
- JAPIĆ, Dajana, PARAMO, Jorge Antonio, **MARINŠEK, Marjan**, STRZHEMECHNY, Yuri M., CRNJAK OREL, Zorica. Growth-morphology-luminescence correlation in ZnO-containing nanostructures synthesized in different media. *Journal of luminescence*, ISSN 0022-2313. [Print ed.], 2012, vol. 132, iss. 6, str. 1589-1596

- KRAJNC, Matjaž, KARGER-KOCSIS, József, **ŠEBENIK, Urška**. Grafting of maleic anhydride onto an ethylene-propylene-diene terpolymer and concurrent organoclay nanocomposite preparation in solution and melt. *Journal of applied polymer science*, ISSN 0021-8995, 2013, vol. 127, no. 2, str. 950-958. [COBISS.SI-ID [35973125](#)]
- KAJTNA, Jernej, **ŠEBENIK, Urška**. Microsphere pressure sensitive adhesives - acrylic polymer/montmorillonite clay nanocomposite materials. *International journal of adhesion and adhesives*, ISSN 0143-7496. [Print ed.], 2009, vol. 29, no. 5, str. 543-550. [COBISS.SI-ID [30208773](#)]
- **ŠEBENIK, Urška**, KRAJNC, Matjaž. Acrylic-clay nanocomposites by suspension and emulsion polymerization. V: MITTAL, Vikas (ur.). *Polymer nanocomposites by emulsion and suspension polymerization*, (RSC nanoscience & nanotechnology, ISSN 1757-7136, no. 16). Cambridge: RSC Pub., cop. 2011, str. 111-123. [COBISS.SI-ID [34554629](#)]

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