UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Nanodelci, koloidna in površinska kemija
Course title:	Nanoparticles, Colloidal and Surface Chemistry

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, 3rd cycle	/	1	1

Vrsta predmeta / Course type Izbirni / Elective

Univerzitetna koda predmeta / University course code: NANO3-816

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Lab. vaje Laboratory 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. Darja Lisjak
Prof. dr. Darko Makovec

Jeziki / Languages:	
Predavanja / Lectures:	Slovenski ali angleški/Slovenian or English
Vaje / Tutorial:	

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Zaključen študij druge stopnje s področja naravoslovja ali tehnologije.	Completed second cycle studies from the field of natural sciences or technology

Vsebina:	**Content (Syllabus outline):**
Splošno o nanodelcih: strukturne, magnetne, elektro-optične in kemijske lastnosti nanodelcev. Kontrolirana sinteza nanodelcev in njihova površinska funkcionalizacija. Fizikalno-kemijske lastnosti površin nanodelcev: površinski naboj, elektrokinetične lastnosti snovi, sile med nanodelci v suspenziji in priprava suspenzij. Površinsko aktivne snovi, prilagajanje površine in funkcionalizacija nanodelcev. Samourejanje in usmerjeno urejanje koloidnih delcev v funkcionalne materiale. Metode vrednotenja površinskih in koloidnih lastnosti delcev in suspenzij. Povezava med kemijo površine in reološkimi lastnostmi koloidnih suspenzij. Izbrani primeri iz narave, raziskovanja in	Basics on nanoparticles: structural, magnetic, electro-optical and chemical properties of nanoparticles. Controlled synthesis of nanoparticles and their surface functionalization. Physico-chemical properties of the nanoparticles' surfaces: surface charge, electrokinetic properties, interparticle forces in suspensions and preparation of suspensions. Surfactants, functionalization and tailoring of nanoparticles' surfaces. Self-assembly and directed assembly of colloidal nanoparticles into functional materials. Methods for the characterization of the surface and colloidal properties of particles and suspensions. Correlation between surface the chemistry of particles and rheological properties of their colloidal

proizvodnih tehnologij.	suspensions. Selected examples from nature, research, production technology.

Temeljni literatura in viri / Readings:

1. T. Sugimoto, Monodispersed Particles, Elsevier, 2001.
2. M.-I. Baraton, Synthesis, Functionalization and Surface Treatment of Nanoparticles, American Science Publications, 2003.
3. G. Schmid, Nanoparticles - From Theory to Application, Wiley-VCH, 2004.
4. Physical Chemistry of Surfaces, 6th Edition, ed. A. W. Adamson, A. P. Gast, John Willey & Sons Inc, 1997
5. Emulsions, Foams, and Suspensions: Fundamentals and Applications, ed. L. L. Schramm, Wiley-VCH Verlag GmbH & Co. KGaA, 2005
6. Introduction to Colloid and Surface Chemistry, 4th Edition, ed. D. J. Shaw, Butterworth, 2000
7. Electrical Phenomena at Interfaces: Fundamentals, Measurements, and Applications, ed. A. Kitahara, A. Watanabe,Marcel Dekker Inc., 1984
8. K. Holmberg, B. Jönsson, B. Kronberg, B. Lindman, Surfactants and Polymers in Aqueous Solution, John Wiley & Sons, LTD, 2003
9. J. N. Israelachvili, Intermolecular and Surface Forces, Academic Press Inc. LTD, 1985
10. M. Hosokawa, K. Nogi, M. Naito and T. Yokoyama (Eds.), Nanoparticle Technology Handbook, Elsevier BV., 2008
11. R. F. Probstein, Physicochemical Hydrodynamics, John Wiley & Sons, 2003
12. F. Caruso (Ed.), Colloids and Colloid Assemblies, Wiley-VCH, 2006
13. Novejši pregledni članki/Up-to-date review articles

Cilji in kompetence:	**Objectives and competences:**
Cilji so seznaniti študente s: - specifiko fizikalno-kemijskih lastnosti nanodelcev, - kontrolirano sintezo nanodelcev, - pomenom nanodelcev pri načrtovanju novih sodobnih materialov, - procesi, ki omogočajo stabilnost koloidnih suspenzij in funkcionalizacijo površin, - metodami vrednotenja površin delcev in interakcij med delci, - primeri iz narave, raziskovanja in industrije. Kompetence: - sposobnost povezave med fizikalno-kemijskimi lastnostmi nanodelcev in njihove možne uporabe, - sposobnost celovitega pristopa k načrtovanju in sintezi uporabnih materialov na osnovi nanodelcev, - uporabiti pridobljeno znanje pri identifikaciji in reševanju problemov, povezanih z razvojem in optimizacijo nanomaterialov.	Objectives are to introduce students with the: - specific physico-chemical properties of nanoparticles, - controlled synthesis of nanoparticles, - importance of nanoparticles in the development of new advanced materials, - colloidal stabilization and surface functionalization of nanoparticles, - characterization methods of nanoparticles surfaces and interparticle interactions, - examples from nature, research and industry. Competences: - ability to correlate physico-chemical properties of nanoparticles with potential applications, - ability to design nanoparticulate materials and their synthesis for potential applications, - integration of acquired knowledge to identify and solve the problems related to the development and optimization of nanomaterials.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Študenti bodo sposobni: - pojasniti specifiko fizikalno-kemijskih lastnosti nanodelcev v primerjavi z volumenskimi materiali, - izbrati primerne metode za kontrolirano sintezo nanodelcev ter njihovo površinsko funkcionalizacijo in koloidno stabilizacijo, - povezati znanje površinske in koloidne kemije ter fizikalno-kemijskih lastnosti nanodelcev z načrtovanjem sodobnih nanostrukturiranih materialov, - izbrati primerne metode vrednotenja nanodelcev, - povezati naučeno s primeri iz narave, laboratorija in industrije, - integrirati pridobljeno znanje pri izvedbi svoje doktorske disertacije.	Students will be able to: - explain the specificity of physico-chemical properties of nanoparticles in comparison to bulk materials, - select suitable methods for the controlled synthesis of nanoparticles, their surface functionalization and colloidal stabilization, - correlate the knowledge on the surface and colloidal chemistry, and physico-chemical properties of nanoparticles with the design of advanced nanostructured materials, - select appropriate characterization methods of nanoparticles, - correlate the acquired knowledge with examples from nature, lab and industry, - integrate the acquired knowledge for accomplishing their PhD thesis.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja Konzultacije Individualno delo s študenti Seminarska naloga	Lectures Consultations Individual work with students Seminar work

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Seminar	50 %	Seminar
Ustna predstavitev seminarja/izpit	50 %	Oral presentation of the seminar/exam

Reference nosilca / Lecturer's references:

- LISJAK, Darja, PLOHL, Olivija, VIDMAR, Janja, MAJARON, Boris, PONIKVAR-SVET, Maja. Dissolution mechanism of upconverting AYF4:Yb,TmAYF4:Yb,Tm (A = Na or K) nanoparticles in aqueous media. *Langmuir*, ISSN 0743-7463, 2016, vol. 32, no. 32, str. 8222-8229, doi: 10.1021/acs.langmuir.6b02675.
- LISJAK, Darja, OVTAR, Simona, KOVAČ, Janez, GREGORATTI, Luca, ALEMAN, Belen, AMATI, Matteo, FANETTI, Mattia, MAKOVEC, Darko. A surface-chemistry study of barium ferrite nanoplates with DBSa-modified surfaces. *Applied Surface Science*, ISSN 0169-4332. [Print ed.], 2014, vol. 305, str. 366-374, doi: 10.1016/j.apsusc.2014.03.092.
- MERTELJ, Alenka, LISJAK, Darja, DROFENIK, Mihael, ČOPIČ, Martin. Ferromagnetism in suspensions of magnetic platelets in liquid crystal. *Nature : the international weekly journal of science*, ISSN 0028-0836. [Print ed.], 2013, vol. 504, no. 7479, str. 237-241, doi: 10.1038/nature12863.
- BELEC, Blaž, DRAŽIĆ, Goran, GYERGYEK, Sašo, PODMILJŠAK, Benjamin, GORŠAK, Tanja, KOMELJ, Matej, NOGUÉS, Julio J., MAKOVEC, Darko. Novel Ba-hexaferrite structural variations stabilized on the nanoscale as building blocks for epitaxial bi-magnetic hard/soft sandwiched maghemite/hexaferrite/maghemite nanoplatelets with out-of-plane easy axis and enhanced magnetization. *Nanoscale*, ISSN 2040-3372, [in press] 2017, 10 str., doi: 10.1039/C7NR05894B.
- PUŠNIK, Klementina, PETERLIN, Mojca, KRALJ CIGIĆ, Irena, MAROLT, Gregor, KOGEJ, Ksenija, MERTELJ, Alenka, GYERGYEK, Sašo, MAKOVEC, Darko. Adsorption of amino acids, aspartic acid, and lysine onto iron-oxide nanoparticles. *The journal of physical chemistry. C, Nanomaterials and interfaces*, ISSN 1932-7447, 2016, vol. 120, iss. 26, str. 14372-14381, ilustr. http://pubs.acs.org/doi/pdf/10.1021/acs.jpcc.6b03180, doi: 10.1021/acs.jpcc.6b03180.