UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	SODOBNI ANORGANSKI MATERIALI IN KATALIZATORJI
Course Title:	MODERN INORGANIC MATERIALS AND CATALYSTS

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
MAG Kemija, 2. stopnja	/	1.	2.
USP Chemistry, 2nd Cycle	/	1st	2nd

Vrsta predmeta / Course Type: obvezni/ Mandatory

Univerzitetna koda predmeta / University Course Code: K2I03

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
30	30	15 LV	/	/	75	5

Nosilec predmeta / Lecturer: doc. dr. Romana Cerc Korošec / Dr. Romana Cerc Korošec, Assistant Professor
prof. dr. Anton Meden / Dr. Anton Meden, 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:

Kemija materialov:
- uvod: različni tipi materialov in njihova uporaba;
- vplivi kemijske sestave, molekularne in kristalne (ali amorfne) strukture ter mikrostrukture materialov na njihovo funkcijo, polimorfizem;
- primeri različnih oblik materialov: monoliti, volumenski materiali, monodisperzni delci, tanki filmi, nano delci;
- kemijske osnove in pregled nekaterih postopkov priprave različnih materialov - na primer: reakcije v trdnem, hidrotermalna sinteza, sol-gel metoda, sinteza z uporabo

Content (Syllabus outline):

Materials chemistry:
- introduction: different types of materials and their application;
- the influence of chemical composition, molecular and crystal (or amorphous) structure and microstructure of materials on their function, polymorphism;
- examples of different forms of materials: monoliths, bulk materials, monodispersed particles, thin films, nano-particles.
- chemical basis and overview of some preparation procedures of different materials – for instance: solid-state reactions, hydrothermal synthesis, sol-gel method, microwave synthesis,

mikrovalov, zgorevalna sinteza, koprecipitacija, priprava monodisperznih delcev, tankih filmov, nanodelcev; - električne, magnetne in optične lastnosti materialov; - osnove heterogene katalize (mehanizem in kinetika reakcij na površini). **Pregled različnih vrst materialov, njihove priprave, strukture in lastnosti:** - molekule v trdninah, samo-urejanje ob kristalizaciji, vpliv oblike molekul na kristalno strukturo; - anorganski, in kovinsko – organski polimeri ter kompoziti; - stekla in keramike, fazni diagrami; - oksidi in nitridi, polprevodniki (dopirani); - kovine in zlitine, napake v kristalih in njihove posledice; - tekoči kristali; **Primeri materialov in njihove uporabe:** - porozni zeolitni in zeolitom podobni katalizatorji; - materiali za shranjevanje in proizvajanje energije – komponente gorivnih celic, baterij in akumulatorjev, trdni ionski prevodniki in fotoelektrokemijske celice; - fotokatalizatorji; - luminiscentni materiali; - kromogeni materiali (elektrokromni, gasokromni, fotokromni, termokromni). - različni nanomateriali. **Vaje:** Skupinska izvedba projekta priprave in karakterizacije materiala po podatkih iz literature.	combustion synthesis, co-precipitation, preparation of uniform particles, thin films, nanoparticles; - electrical, magnetic and optical properties of materials; - the basis of heterogeneous catalysis (mechanism and kinetics of surface reactions). **Overview of different materials, their preparation, structure and properties:** - molecules in solids, self-assembling during crystallization, the influence of molecule`ş shape on crystal structure; - inorganic and metal-organic polymers and composites; - glasses and ceramic materials, phase diagrams; - oxides and nitrides, semiconductors (doped); - metals and alloys, crystal defects and their consequences; - liquid crystals; **Case-studies of materials and their application:** - porous zeolites and zeolite-like catalysts; - materials for energy storage and its production – components of fuel cells, batteries, solid ionic conductors, photoelectrochemical cells, - photocatalysts, - luminescent materials; - chromogenic materials (electrochromic, gasochromic, photochromic, thermochromic) - various nanomaterials. **Practical lab:** Student team performs project from preparation to characterization of materials according to data obtained from the literature.

Temeljna literatura in viri / Readings:

- Introduction to Materials Chemistry, H.A. Allcock, Wiley, 2008, 460 strani (30%).
- Inorganic Materials Chemistry, M.T. Weller, Oxford University Press, 2005, 92 strani (50%).
- Synthesis of Inorganic Materials, U. Schubert and N. Hüsing, Wiley, 2. Izdaja, 2005, 409 strani (25 %).
- The Basis and Application of Heterogeneous Catalysis, M. Bowker, Oxford University Press, 1998, 90 strani (70%).

Cilji in kompetence:	**Objectives and Competences:**
Cilji: Poglobljeno spoznavanje določenih tipov sodobnih anorganskih materialov in katalizatorjev, sinteznih tehnik in raznivrstnih metod za njihovo karakterizacijo. *Kompetence:* Izpeljava celotnega projekta: sinteza in karakterizacije tako katalizatorja kot anorganskega materiala, vključno z literaturnim pregledom in načrtovanjem.	Objectives: Acquiring in-depth knowledge of certain modern inorganic materials, preparation techniques and characterization methods. Competences: Students acquire competences to carry out a project involving synthesis and characterization, both for the catalyst or inorganic material, including a literature survey and planning.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Podrobno poznavanje izbranih vrst anorganskih materialov ter katalizatorjev in lasnosti, ki so povezane s strukturo, morfologijo in obliko posameznega materiala. Poznavanje različnih preparativnih tehnik za njihovo pripravo in raznovrstnih metod karakterizacije. Povezava teoretičnega in praktilnega znanja z izvedbo dveh različnih projektnih nalog: sinteza in karakterizacija novega materiala ter sinteza in karakterizacija katalizatorja.	Knowledge and Comprehension In-depth knowledge of selected types of inorganic materials and catalysts and their properties, which originate from the structure, morphology and shape of the material. Knowledge of different preparation techniques and characterization methods. Connection between theoretical and practical knowledge through performing two different projects: synthesis and characterisation of a new material and synthesis and characterisation of a catalyst.
Uporaba Pridobljeno znanje zna povezati in s pomočjo dosegljive literature načrtovati modificirane sintezne postopke priprave novega materiala oz. katalizatorja. Poznavanje metod karakterizacije, njihovo komplementarnost in dopolnjevanje vodijo v razumevanje vsebine znanstvenih člankov s področja materialov.	Application Integration of acquired knowledge and planning modificating synthesis routes for the preparation of a new material or catalyst with the aid of available literature. The knowledge of characterisation methods and the ways they complement one another leads to the understanding of the contents of research articles in the field of materials chemistry.
Refleksija Študent razume in utrdi razumevanje povezave med lastnostmi in sestavo ter zgradbo snovi na teoretičnem nivoju, na dveh konkretnih, samostojno izvedenih primerih pa je sposoben novo znanje uporabiti v praksi, kar vodi v samostojno načrtovanje in karakterizacijo novih materialov oz. katalizatorjev.	Analysis The student solidifies the understanding of the connections between properties, composition and structure of material on a theoretical level. Acquired knowledge is then transferred to the practical level and applied to two specific cases. This enables independent planning and characterisation of new materials and catalysts.
Prenosljive spretnosti Študent zna uporabljati zbirke podatkov, izbrati najbolj primerne sintezne postopke za	Skill-transference Ability The student is able to use databases, chooses the most appropriate synthesis routes for the

pripravo novega materiala oz. katalizatorja in ve, katere metode karakterizacije bo potreboval. Ker vseh metod karakterizacije ni mogoče individualni izvesti, se sooči s »timskim« delom. Rezultate karakterizacije zna kritično ovrednotiti in z njihovo pomočjo optimirati sintezni postopek, da bo dobljeni material izboljšal. Pisno in ustno zna poročati o rezultatih projektne naloge in jih komentirati.	preparation of a new material or catalyst and knows which characterisation methods are required. Since not all characterisation methods can be performed individually, group work is required. The student is able to critically evaluate the results obtained from characterisation and uses them as a basis for the optimisation of the synthesis procedures in order to obtain materials with the best properties. The student can report and comment on the results of the project in both written and oral form.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
- predavanja - seminar - izpeljava projektne naloge	- Lectures - Seminars - Execution of one project

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pogoj za pristop k izpitu je oddano poročilo o projektu (zaključene vaje). Pisni izpit. Ocene 6-10: pozitivno, ocene 1-5: negativno.		Submitted project report (completed practice) is mandatory before the exam. Written exam. Marks 6-10: pass, marks 1-5: fail.

Reference nosilca / Lecturer's references:

Romana Cerc Korošec:

1. P. Galer, R. Cerc Korošec, M. Vidmar, B. Šket. Crystal structures and emission properties of the BF2 complex 1-phenyl-3-(3,5-dimethoxyphenyl)-propane-1,3-dione : multiple chromisms, aggregation- or crystallization-induced emission, and the self-assembly effect. Journal of the American Chemical Society, 136 (20), 7383-7394, 2014.
2. M. Sluban, N, Rozman, M. Pregelj, C. Bittencourt, R. Cerc Korošec, A. Sever Škapin, A. Mrzel, S. D. Škapin, P. Umek. Transformation of hydrogen titanate nanoribbons to TiO2 nanoribbons and the influence of the transformation strategies on the photocatalytic performance. Beilstein journal of nanotechnology, 6, 831-844, 2015.
3. R. Cerc Korošec, P. Bukovec. Optimisation of the thermal-treatment of chemically prepared electrochromic nickel oxide thin films, their electrochromic properties and structural investigations. V: P.R. SOMANI(ur.). Chromic materials, phenomena and their technological applications, (Multifunctional materials and devices). Pune: Applied Science Innovations Private Limited, str. 241-282, 2010.

Anton Meden:

1. M. VIdmar, A. Golobič, A. Meden, D. Suvorov, S. D. Škapin. Sub-solidus phase relations and a structure determination of new phases in the $CaO\text{-}La_2O_3\text{-}TiO_2$ system. *Journal of the European ceramic society*, 35, 2801-2814, 2015.

2. Y. Sadikin, K. Stare, P. Schouwink, M. B. Ley, T. Jensen, A. Meden, R. Černy. Alkali metal - yttrium borohydrides : the link between coordination of small and large rare-earth. *Journal of solid state chemistry*, 225, 231-239, 2015.
3. F. Zupanič, B. Markoli, I. Naglič, T. Weingaertner, A. Meden, T. Bončina. Phases in the Al-corner of the Al-Mn-Be system. *Microscopy and microanalysis*, 19(5), 1308-1316, 2013.