UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Keramični materiali
Course title:	Ceramic Materials

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:	NANO3-883

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:	Doc. dr. Andraž Kocjan Prof. dr. Tomaž Kosmač
Jeziki / Languages: Predavanja / Lectures:	Slovenski ali angleški / Slovene or English
Seminar:	Angleški / 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):**
Študentje se seznanijo z osnovami keramičnega procesiranja ter nekaterih lastnostih keramičnih materialov, predvsem tistih, ki se uporabljajo za napredne strukturne in biomedicinske aplikacije. Seznanijo se z zakonitostmi procesiranja keramičnih prahov. Spoznajo tako tradicionalne kot tudi napredne tehnike oblikovanja keramičnih izdelkov. Spoznajo proces sintranja keramike in razvoj mikrostrukture, ki v veliki meri določa končne lastnosti keramičnih materialov, katere razložimo preko spoznavanja tehnik karakterizacije. Spoznavajo lastnosti biokompatibilnih keramičnih sistemov. Seznanijo se s pregledom uporabe keramičnih materialov za napredne strukturne in	Students learn about the principles of ceramic processing and some of the properties of ceramic materials, especially those used for advanced structural and biomedical applications. Students learn basic principles of ceramic powder processing and get familiar with both traditional as well as advanced techniques for the shaping of ceramic components. They learn about the sintering processes and the evolution of microstructure, which largely determines the final ceramic properties, which are explained by means of different characterization techniques. Students will learn about different biocompatible ceramic systems. An overview of the use of ceramic

biomedicinske aplikacije.	materials for advanced structural and biomedical applications will also be given.

Temeljni literatura in viri / Readings:

- W. D. Kingery, Introduction to Ceramics. John Wiley & Sons, Inc., 2013
- J. S. Reed, Principles of Ceramics Processing. 2nd ed. John Wiley & Sons, Inc., 1995
- Y-M. Chiang, D. P. Birnie, W. D. Kingery, Physical Ceramics: Principles for Ceramic Science and Engineering. John Wiley & Sons, Inc., 1995
- T. Kokubo, Bioceramics and their clinical applications. Woodhead Publishing Limited, 2008
- Z. Shen, T. Kosmač, Advanced Ceramics for Dentistry. Elsevier, 2014
- Novejši relevantni znanstveni članki

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je usposobiti študente za razumevanje osnov o keramičnem procesiranju ter o nekaterih lastnostih keramičnih materialov, predvsem tistih, ki se uporabljajo za napredne strukturne in biomedicinske aplikacije. Cilj se navezuje na kompetence: • razumevanje zakotnosti procesiranja keramičnih prahov, • poznavanje različnih tehnik oblikovanja keramičnih izdelkov, • razumevanje procesa sintranja keramike in razvoj mikrostrukture, • sposobnost povezovanja različnih metod karakterizacije in lastnosti keramičnih materialov, • razlikovanje karakteristik in lastnosti keramičnih materialov za napredne strukturne in biomedicinske aplikacije ter • sposobnost uporabe znanja v praksi.	The objective of the course is in student`s ability to understand the basics principles of ceramic processing and some of the properties of ceramic materials, especially those used for advanced structural and biomedical applications. The objective is related to competences: • understanding principles of ceramic powder processing, • knowledge about different techniques for the shaping of ceramic components, • understanding the process of sintering of ceramics and the evolution of microstructure, • ability to differentiate between characterisation methods and related ceramic properties, • understanding different characteristics and properties of ceramic materials for advanced structural and biomedical applications and • ability to use the knowledge in practice.

Predvideni študijski rezultati (izidi):	**Intended learning outcomes:**
• Razumeti zakonitosti procesiranja keramičnih prahov. • Razlikovati med tradicionalnimi in naprednimi tehnikami oblikovanja keramičnih izdelkov. • Pojasniti specifične lastnosti keramičnih materialov, njihovih prednosti in slabosti v primerjavi z drugimi materiali. • Napovedati zanesljivost/uporabnost keramične komponente glede na lastnosti, določene z uporabljeno metodo karakterizacije. • Načrtovati keramično komponento (sistem in oblikovanje) za obratovanje v relevantnem okolju z zahtevanimi lastnostmi.	• Understand principles of ceramic powder processing. • Differentiate between traditional and advanced ceramic shaping techniques. • Explain specific properties of ceramics, their pros and cons concerning other materials. • Predict reliability/applicability of the ceramic component with respect to the properties as determined by given characterisation method. • Design ceramic component (system and shaping) for its operation in a given relevant environment with expected properties. • Establish the ability to communicate in English

• Vzpostaviti sposobnost komunikacije v angleškem jeziku s strokovnjaki s področja keramike.	with the ceramists professionals.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Uvodna predstavitev - predavanja. Seminarsko skupinsko delo. Vključevanje v projekte za razvoj sposobnosti izvajanja keramičnega procesiranja. Uporaba raziskovalne opreme in metod za karakterizacijo za razumevanje ter določanje lastnosti keramičnih materialov.	Introductory presentation - lectures. Seminar team work. Participation in projects for the development of the ability to conduct ceramic processing. Using research equipment and characterization methods for the understanding and determination of ceramic properties.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Seminarska naloga. Zagovor seminarske naloge, pri katerem 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:

- BUČEVAC, Dušan, KOSMAČ, Tomaž, KOCJAN, Andraž. The influence of yttrium-segregation-dependent phase partitioni ng and residual stresses on the aging and fractur e behaviour of 3Y-TZP ceramics. *Acta biomaterialia*, ISSN 1742-7061, [in press] 2017, 38 str., doi: 10.1016/j.actbio.2017.08.014. [COBISS.SI-ID 30688295]
- COTIČ, Jasna, JEVNIKAR, Peter, KOCJAN, Andraž. Ageing kinetics and strength of airborne-particle abraded 3Y-TZP ceramics. *Dental materials*, ISSN 0109-5641. [Print ed.], 2017, vol. 33, iss. 7, str. 847-856, doi: 10.1016/j.dental.2017.04.014. [COBISS.SI-ID 33233881]
- KOCJAN, Andraž, KONEGGER, Thomas, DAKSKOBLER, Aleš. Hierarchical macroporous-mesoporous γ-alumina monolithic green bodies with high strength. *Journal of Materials Science*, ISSN 0022-2461, 2017, vol. 52, no. 19, str. 11168-11178, doi: 10.1007/s10853-017-0894-z. [COBISS.SI-ID 30266151]
- KOCJAN, Andraž, LOGAR, Manca, SHEN, Zhijian. The agglomeration, coalescence and sliding of nanoparticles, leading to the rapid sintering of zirconia nanoceramics. *Scientific reports*, ISSN 2045-2322, 2017, vol. 7, str. 2541-1- 2541-8, doi: 10.1038/s41598-017-02760-7. [COBISS.SI-ID 30524455]
- SHEN, Zhijian, LIU, Leifeng, XU, Xiqing, ZHAO, Jing, ERIKSSON, Mirva, ZHONG, Yuan, ADOLFSSON, Erik, LIU, Yihong, KOCJAN, Andraž. Fractography of self-glazed zirconia with improved reliability. *Journal of the European ceramic society*, ISSN 0955-2219. [Print ed.], [in press] 2017, 7 str., doi: 10.1016/j.jeurceramsoc.2017.03.008. [COBISS.SI-ID 30338087]