UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Povezava med kristalno strukturo in lastnostmi senzorskih materialov
Course title:	Interplay Between Crystal Structure and Material's Sensing Properties

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Senzorske tehnologije, 3. stopnja	/	1	1
Sensor Technologies, 3rd cycle	/	1	1

Vrsta predmeta / Course type Izbirni / Elective

Univerzitetna koda predmeta / University course code: ST3-892

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. Andreja Benčan Golob
Prof. dr. Goran Dražić

Jeziki / Languages:	**Predavanja / Lectures:**	Slovenščina, angleščina / Slovenian, English
	Vaje / Tutorial:	-

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Zaključen študij druge stopnje ustrezne (naravoslovne ali tehniške) smeri ali zaključen študij drugih smeri z dokazanim znanjem 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):**
Povezava med kristalno strukturo, napakami kristalne strukture in lastnostmi materialov Pregled metod za študij kristalnih napak (kot na primer elektronska mikroskopija na atomskih ravni, elektronska difrakcija, spektroskopija izgub energije elektronov) Podrobna predstavitev izbranih sodobnih senzorjev s stališča materialov, njihove kristalne strukture in kristalnih napak (kot na primer volumenski, plastni materiali, 2D heterostrukturni materiali)	Interplay between the crystal structure, the defects of the crystal structure and the properties of materials Review of methods for crystal defects study (for example, electron microscopy at atomic level, electron diffraction, electron energy loss spectroscopy) Detailed presentation of selected advanced sensors from the materials crystal structure and crystal defects point of view (for example, bulk, layered materials, 2D heterostructure materials)

Temeljni literatura in viri / Readings:

Crystal, defects and microstructures, Modeling Across Scales, R. Philips, Cambridge,2004
The science and engineering of materials, 6th edition, D. R. Askeland, P. P. Fulay, W.J. Wright, Cengage, 2011

Izbrani članki predvsem v revijah Nature Materials, Advanced Functional Materials, Progress in Materials Science, Chemistry of Materials, Acta materialia, Sensors and Actuators, Journal of the American Ceramic Society, Journal of European Ceramic Society in pregledni članki.
Targeted selection of papers from Nature Materials, Advanced Functional Materials, Progress in Materials Science, Chemistry of Materials, Acta materialia, Sensors and Actuators, Journal of the American Ceramic Society, Journal of the European Ceramic Society and review articles.

Cilji in kompetence:

Študenti razlikujejo najnovejše senzorske materiale s stališča kristalnih značilnostih in metode karakterizacije kristalne strukture in kristalnih napak na atomski ravni.

Kompetence:
- povezovati kristalno strukturo in prisotnost strukturnih napak s specifičnimi lastnostmi senzorskih materialov
-sposobnost za samostojno raziskovalno delo
-sposobnost uporabe znanj v praksi

Objectives and competences:

Students distinguish the latest sensor materials from crystal characteristics point of view of and the methods of characterization of crystal structure and defects at atomic level.

Competences:
-ability to link the crystal structure and the presence of structural defects with specific properties of sensor materials
-ability to carry out independent research work
- ability to use the knowledge in practice

Predvideni študijski rezultati:

Študent bo na osnovi pridobljenega znanja:
- obvladal osnovne tipe kristalnih struktur in napak materialov,
- izbral primerno metodo karakterizacije kristalnih napak in napovedal njene eksperimentalne omejitve,
- znal interpretirati rezultate analiz,
- znal povezovati znanja o kristalni strukturi, kristalnih napakah z lastnostmi senzorskih materialov na primeru reševanja konkretnega primera v okviru doktorskega študija.

Intended learning outcomes:

The student will:
- master knowledge of crystal structure types and defects in materials
- select suitable methods of crystal defects characterization and forecast its experimental limitations
- interpret the results of analysis
- be able to correlate knowledge about crystal structure, crystal defects with properties of sensor material to solve a case-study related to the PhD research.

Metode poučevanja in učenja:

Interaktivna predavanja.
Individualno voden študij, ki vključuje reševanje izbranega primera in predstavitev rezultatov v obliki seminarske naloge.

Learning and teaching methods:

Interactive lectures.
Individually guided study which includes a case-study and presentation of results as a seminar.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Seminarska naloga	50 %	Seminar
Zagovor seminarske naloge	50 %	Defence of seminar

Reference nosilca / Lecturer's references:

1.ROJAC, Tadej, BENČAN, Andreja, DRAŽIĆ, Goran, SAKAMOTO, Naonori, URŠIČ, Hana, JANČAR, Boštjan, TAVČAR, Gašper, MAKAROVIČ, Maja, WALKER, Julian, MALIČ, Barbara, DAMJANOVIĆ, Dragan. Domain-wall conduction in ferroelectric $BiFeO_3$ controlled by accumulation of charged defects. Nature materials, ISSN 1476-1122, 2017, vol. 16, no. 3, str. 322-327, doi: 10.1038/nmat4799. [COBISS.SI-ID 29936679]

2.ROJAC, Tadej, URŠIČ, Hana, BENČAN, Andreja, MALIČ, Barbara, DAMJANOVIĆ, Dragan. Mobile domain walls as a bridge between nanoscale conductivity and macroscopic electromechanical response. Advanced functional materials, ISSN 1616-301X, 2015, vol. 25, no. 14, str. 2099-2108, doi: 10.1002/adfm.201402963. [COBISS.SI-ID 28359975]

3.HREŠČAK, Jitka, DRAŽIĆ, Goran, DELUCA, Marco, ARČON, Iztok, KODRE, Alojz, DAPIAGGI, Monica, ROJAC, Tadej, MALIČ, Barbara, BENČAN, Andreja. Donor doping of K0.5Na0.5NbO3
ceramics with strontium and its implications to grain size, phase composition and crystal structure. Journal of the European ceramic society, ISSN 0955-2219. [Print ed.], 2017, vol. 37, iss. 5, str. 2073-2082, ilustr., doi: 10.1016/j.jeurceramsoc.2016.12.053. [COBISS.SI-ID 4638715]

4.WALKER, Julian, BRYANT, Peter, KURUSINGAL, Valsala, SORRELL, Charles C., KUŠČER, Danjela, DRAŽIĆ, Goran, BENČAN, Andreja, VALANOOR, Nagarajan, ROJAC, Tadej. Synthesis-phase-composition relationship and high electric-field-induced electromechanical behavior of samarium-modified BiFeO3 ceramic. Acta materialia, ISSN 1359-6454. [Print ed.], 2015, str. 149-159, doi: 10.1016/j.actamat.2014.09.058. [COBISS.SI-ID 28038439]

5.MILIĆEVIĆ, Bojana, ĐORĐEVIĆ, Vesna, VUKOVIĆ, Katarina, DRAŽIĆ, Goran, DRAMIĆANIN, Miroslav D. Effects of Li+co-doping on properties of Eu3+activated TiO2 anatase nanoparticles : Bojana Milićević ... [et al.]. Optical Materials, ISSN 0925-3467. [Print ed.], Oct. 2017, vol. 72, str. 316-322, ilustr., doi: 10.1016/j.optmat.2017.06.029. [COBISS.SI-ID 6193178]