



### UČNI NAČRT PREDMETA / COURSE SYLLABUS

<b>Predmet</b>	Fizika površin
<b>Course name</b>	Surface physics

Študijski program in stopnja Study program and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Fizika in Astrofizika II. stopnja	Fizika trdne snovi	2	/
Physics and Astrophysics II. level	Fizika trdne snovi	2	/

<b>Vrsta predmeta / Course type</b>	obvezni / mandatory
<b>Univerzitetna koda predmeta / University course code</b>	2FTS12

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Lab. work	Teren. vaje Field work	Samost. delo Indiv. work	ECTS
60	/	30	/	/	180	9

<b>Nosilec predmeta / Lecturer</b>	prof. dr. Sandra Gardonio	
<b>Jeziki / Languages</b>	<b>Predavanja / Lectures</b>	slovenščina / english
	<b>Vaje / Tutorial</b>	slovenščina / english

<b>Pogoji za opravljanje študijskih obveznosti</b>	<b>Prerequisites</b>
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Vsebina	Syllabus outline
Osnove dvodimenzionalne kristalografije	Basic of two dimensional crystallography
Eksperimentalno ozadje (ultra-visoki vakuum, priprava čistih površin, UHV tehnologija nanašanja)	Experimental background (ultra-high vacuum, preparation of clean surfaces, UHV deposition technology)
Difrakcijske metode za analizo površin (LEED in RHEED)	Diffraction methods for surface analysis (LEED and RHEED)
Metode elektronske spektroskopije za analizo površin (Spektroskopija Augerjevih elektronov, Fotoelektronska spektroskopija)	Electron spectroscopy methods for surface analysis (Auger Electron spectroscopy, Photoelectron spectroscopy)
Mikroskopija za analizo površin (Presevna elektronska mikroskopija, vrstična elektronska mikroskopijo, vrstična tunelska mikroskopija, mikroskopija atomskih sil)	Microscopy techniques for surface analysis (Transition Electron Microscopy, Scanning Electron Microscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy)



Atomska struktura čistih površin (sprostitvev in rekonstrukcija)	Atomic Structure of Clean Surfaces (relaxation and reconstruction)
Atomska struktura površin z adsorbenti	Atomic structure of Surfaces with Adsorbates
Strukturne pomanjkljivosti na površini	Structural defects at surfaces
Elektronska struktura površin	Electronic structure of surfaces
Adsorpcija in desorpcija	Adsorption and desorption
Rast tankih plasti	Growth of thin films
Atomska manipulacija in priprava nanodelcev	Atomic manipulation and nanostructure formation

#### Temeljni literatura in viri / Basic readings

K. Oura, V. G. Lifshits, A. A. Saranin, A.V. Zotov and M. Katayama Surface Science An introduction, Springer (2003).

Hans Lüth, Solid Surfaces, Interfaces and Thin Film, Springer (2010).

Cilji in kompetence	Objectives and competences
<p>Površine igrajo ključno vlogo pri zelo velikem številu pojavov. To še posebej velja za sodobne nano-materiale, kjer so površinski atomi velik odstotek celote.</p> <p>Glavni cilji so:</p> <p>Analiza lastnosti površin in njihova povezava s strukturo, kemijo in fiziko.</p> <p>Pridobiti znanje o metodah za karakterizacijo površin in kakšne informacije z njimi pridobimo.</p> <p>Pridobiti znanje o trenutnih metodah za modifikacijo površin.</p>	<p>Surfaces play a crucial role in a very large number of phenomena. This is particularly true with modern nano-size materials where surface atoms are a large percentage of the total.</p> <p>The main objectives therefore are:</p> <p>To analyze properties of a surfaces and correlate them to structure, chemistry, and physics.</p> <p>To know methods for the characterization of surfaces and what information they such methods give.</p> <p>To know current methods for the modification of surfaces.</p>

Predvideni študijski rezultati	Intended learning outcomes
<p>Po zaključku tega predmeta bo študent sposoben:</p> <p>Razumeti strukturo in lastnosti površin ter kako</p>	<p>Upon completion of the course, the student is able to:</p> <p>Understand the structure and properties of</p>



<p>se razlikujejo od lastnosti celote materialov.</p> <p>Razumeti, predvideti in načrtovati površinske lastnosti, ki temeljijo na površinski strukturi</p> <p>Razumeti fizikalna in kemijska ozadja površinskih pojavov.</p> <p>Predlagati skupnih tehnike karakterizacije za določanje površinske strukture.</p>	<p>surfaces and how they are different from the bulk properties of materials.</p> <p>Understand, predict and design surface properties based on surface structure</p> <p>Understand the physics and chemistry behind surface phenomena.</p> <p>Suggest common characterization techniques for the determination of surface structure.</p>
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Metode poučevanja in učenja	Learning and teaching methods
<p>- predavanja</p> <p>- računske vaje</p>	<p>- lectures</p> <p>- tutorial</p>

Načini ocenjevanja	Utež / Weight (%)	Assessment
ustni izpit	100	oral exam

#### Reference nosilca / references of the course principal

Prof. dr. Sandra Gardonio je izredna profesorica za področje fizike na Univerzi v Novi Gorici.  
Dr. Sandra Gardonio is associate professor of physics s at the University of Nova Gorica.

Izbrane objave / selected references:

- MORAS, Paolo, BIHLMAYER, G., SHEVERDYAEVA, P. M., MAHATHA, S. K., PAPAGNO, M., SÁNCHEZ-BARRIGA, J., RADER, O., NOVINEC, Luka, GARDONIO, Sandra, CARBONE, Carlo. Magnetization-dependent Rashba splitting of quantum well states at the Co/W interface. Physical review. B, Condensed matter and materials physics, ISSN 1098-0121, 2015, vol. 91, no. 19, str. 195410-1-195410-8, ilustr., doi: 10.1103/PhysRevB.91.195410. [COBISS.SI-ID 3924219]
- GARDONIO, Sandra, KAROLAK, Michael, WEHLING, Tim Oliver, PETACCIA, Luca, LIZZIT, Silvano, GOLDONI, Andrea, LICHTENSTEIN, Alexander, CARBONE, Carlo. Excitation spectra of transition-metal atoms on the Ag (100) surface controlled by hund's exchange. Physical review letters, ISSN 0031-9007. [Print ed.], 2013, vol. 110, no. 18, str. 186404-1-186404-5. [COBISS.SI-ID 2741755]
- DRAGOMIR, Mirela, ARČON, Iztok, GARDONIO, Sandra, VALANT, Matjaž. Phase relations and optoelectronic characteristics in the NdVO<sub>4</sub>-BiVO<sub>4</sub> system. Acta materialia, ISSN 1359-6454. [Print ed.], Feb. 2013, vol. 61, no. 4, str. 1126-1135, doi: 10.1016/j.actamat.2012.10.020. [COBISS.SI-ID 21319654]
- GARDONIO, Sandra, WEHLING, Tim Oliver, PETACCIA, Luca, LIZZIT, Silvano, VILMERCATI, Paolo, GOLDONI, Andrea, KAROLAK, Michael, LICHTENSTEIN, Alexander, CARBONE, Carlo. Spectral functions of isolated Ce adatoms on paramagnetic surfaces. Physical



review letters, ISSN 0031-9007. [Print ed.], 2011, vol. 107, no. 2, str. 026801-1-026801-4. [COBISS.SI-ID 1968635]

5. CARBONE, Carlo, GARDONIO, Sandra, MORAS, Paolo, LOUNIS, Samir, HEIDE, Marcus, BIHLMAYER, Marcus, ATODIRESEI, Nicolae, DEDERICHS, Peter Heinz, BLÜGEL, Stefan, VLAIC, Sergio, LEHNERT, Anne, OUAZI, Safia, RUSPONI, Stefano, BRUNE, Harald, HONOLKA, Jan, ENDERS, Axel, KERN, Klaus, STEPANOW Sebastian, KRULL, Cornelius, BALASHOV, Timofey, MUGARZA, Aitor, GAMBERDELLA, Pietro, Self-assembled nanometer-scale magnetic networks on surfaces : fundamental interactions and functional properties. *Advanced functional materials*, ISSN 1616-301X, apr. 2011, vol. 21, no. 7, str. 1212-1228. [COBISS.SI-ID 1908475]

6. CARBONE, C., GARDONIO, Sandra, et al. Correlated electrons step by step : itinerant-to-localized transition of Fe impurities in free-electron metal hosts. *Physical review letters*, ISSN 0031-9007. [Print ed.], 19. mar. 2010, vol. 104, no. 11, str. 117601-1-117601-4. [COBISS.SI-ID 1475835]