

28. Međunarodni Znanstveni Sastanak Vakuumska Znanost i Tehnika

Crikvenica, 18-20. Svibanj 2022

28. Mednarodno Znanstveno Srečanje Vakuumska Znanost in Tehnika

Crikvenica, 18-20. Maj 2022

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Crikvenica, 18-20 May 2022

Book of abstracts

Editors Maja Mičetić, Krešimir Salamon

Hrvatsko vakuumsko društvo 2022

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General information

The meeting will be held in Hotel Katarina, Crikvenica, Croatia, May 18 - 20, 2022. The main aim of the meeting is to bring together researchers, engineers, technicians and other experts to share their knowledge on the recent developments in the field of Vacuum science and technology and related areas.

International Scientific Meeting on Vacuum Science and Technique is traditionally organized each year by Vacuum Societies of Croatia and Slovenia. It provides the most recent scientific achievements across a broad range of vacuum related scientific disciplines.

Registration desk hours:

Wendsday, May 18th,.....11:30-12:30

Topics:

- Applied Surface Science
- Electronic Materials and Processing
- Vacuum Science and Technology
- Plasma Science and Technique
- Thin Films and Coatings
- Surface Science
- Biointerfaces
- Nanometer Structures
- Vacuum Metallurgy
- Nuclear Physics



Program at a glance

Wendsday May 18 ^h , 2022			
Registration	11:30 - 12:30		
Lunch	12:30 – 13:55		
Opening	13:55 – 14:00		
Plenary lecture	14:00 - 14:35		
Invited lectures	14:35 – 15:25		
Break	15:25 - 16:00		
Keynote lecture	16:00 - 16:25		
Invited lectures	16:25 – 17:15		
Dinner	18:30 - 20:00		
Poster session	20:00 - 22:00		

Thursday May 19 ^h , 2022			
8:00 - 9:00			
9:00 - 9:25			
9:25 - 10:40			
10:40 - 11:10			
11:10 - 11:35			
11:35 – 12:50			
13:00 - 14:30			
14:30 - 18:00			
18:00 - 22:00			

Friday May 20 th , 2022			
Breakfast & room check-out	8:00 - 9:00		
Plenary lecture	9:00 - 9:35		
Invited lectures	9:35 – 10:25		
Break	10:25 - 10.55		
Invited lectures	10:55 – 11:45		
Closing ceremony	11:45 – 12:00		
Lunch	12:00 - 14:00		
Departure	14:00		



Programme schedule

Wednesday (18	.5.2022)	
11:30 - 12:30	Registration	
12:30 - 13:55	Lunch	
13:55 – 14:00	Opening	
14:00-14:35	Plenary lecture chair: Mihael Grbić	Miha Čekada (PL-1) INDUSTRIAL DEPOSITION OF PVD HARD COATINGS – A PERSPECTIVE FROM VACUUM SCIENCE AND TECHNIQUE
14:35 – 15:00	Invited lectures chair:	Dane Lojen (IL-1) LOW PRESSURE PLASMA FUNCTIONALISATION OF FLUOROPOLYMERS
15:00 - 15:25	Mihael Grbić	Martina Vrankić (IL-2) PRESSURE-DRIVEN AND PHOTOCATALYTIC DIVERSITY OF SHAPE-SELECTED ZnO PARTICLES
15:25 - 16:00	Coffee break	
16:00-16:25	Keynote lecture chair: Janez Kovač	Mihael Grbić (KL-1) ANISOTROPY-DRIVEN QUANTUM CRITICALITY IN AN INTERMEDIATE VALENCE SYSTEM
16:25 – 16:50	Invited lectures	Borna Radatović (IL-3) MACROSCOPIC SINGLE-PHASE MONOLAYER BOROPHENE ON ARBITRARY SUBSTRATES
16:50 – 17:15	chair: Janez Kovač	Mirjam Bajt Leban (IL-4) CORROSION CHARACTERIZATION OF TI-6AL-4V ALLOY WITH DIFFERENT TYPES OF BLUE COLOUR SURFACE OXIDATIONS
18:30 - 20:00	Dinner	
20:00 - 22:00	Poster session and social	
	programe	



Thursday (19.5	.2022)	
7:30 – 8:45	Breakfast	
9:00 – 9:25	Keynote lecture chair: Iva Šrut Rakić	Matjaž Finšgar (KL-2) THE USE OF GAS CLUSTER ION BEAM IN ASSOCIATION WITH XPS/TOF-SIMS AND TANDEM TOF-SIMS FOR THE ANALYSIS OF ORGANIC/INORGANIC INTERFACES
9:25 – 9:50		Maurizio Rodriguez Ramos (1L-5) CAPABILITIES OF THE ION BEAM MICROPROBE AT THE RUĐER BOŠKOVIĆ INSTITUTE
9:50 – 10:15	Invited lectures chair: Iva Šrut Rakić	Ivana Periša (11-6) MAGNETRON SPUTTERING DEPOSITION OF GE BASED CORE/SHELL QUANTUM DOT LATTICES IN ALUMINA MATRIX
10:15 - 10:40		Tim Verbovšek (<i>IL-7</i>) NOVEL IONIZATION GAUGE WITH A STRAIGHT-PATH ELECTRON BEAM
10:40 - 11:10	Coffee break	
11:10 - 11:35	Keynote lecture chair: Matjaž Finšgar	Iva Šrut Rakić (KL-3) HITCHHIKERS GUIDE TO STRAINTRONICS IN 2D MATERIALS - FRACTIONAL LANDAU LEVELS, ANISOTROPIC BANDS AND INTERACTIONS
11:35 – 12:00		Neven Šantić (۱۱-8) TOWARDS THE FIRST STRONTIUM OPTICAL ATOMIC CLOCK IN CROATIA
12:00 - 12:25	Invited lectures chair: Matjaž Finšgar	Andreja Jagodar (11-9) MULTIMATERIALS BASED ON LOW TEMPERATURE PLASMA GROWN GRAPHENE AND LASER PRODUCED METAL AND METAL OXIDE NANOPARTICLES
12:25 – 12:50		Nastja Mahne (IL-10) MONTE CARLO SIMULATIONS OF SPUTTERING YIELD FOR DEPOSITION-RELEVANT TARGET MATERIALS
13:00 - 14:30	Lunch	
14:30-18:00	Discussions	
18:00 - 22:00	Dinner and social event	



Friday (20.5.20	22)	
7:30 – 8:45	Breakfast	
9:00-9:35	Plenary chair: Maurizio Rodriguez Ramos	Tonči Tadić <i>(PL-2)</i> FUZIJA, ITER I DONES
9:35 – 10:00	Invited Lectures chair: Maurizio Rodriguez Ramos	Jure Žigon (IL-11) SURFACE TREATMENT OF LIGNOCELLULOSIC MATERIALS WITH DIELECTRIC BARRIER DISCHARGE IN CONFIGURATION WITH FLOATING ELECTRODE
10:00 -10:25		Aleksandar Opančar (IL-12) BIOELECTRONIC INTERFACES BY PVD OF SEMICONDUCTING ORGANIC PIGMENTS
10:25 - 10:55	Coffee break	
10:55– 11:20	Invited Lectures	Marta Klanjšek Gunde (IL-13) IRREVERSIBLE THERMOCHROMICS AND THE NEED OF VACUUM-RELATED TECHNOLOGIES
11:20 - 11:45	chair: Borna Radatović	Matej Bubaš (IL-14) HYBRID METAL NANOISLANDS AS PLASMON-BASED SENSORS
11:45 - 12:00	Closing ceremony	
12:00 - 14:00	Lunch	
14:00	Departure	





Abstracts Plenary Lectures



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PL-1 INDUSTRIAL DEPOSITION OF PVD HARD COATINGS – A PERSPECTIVE FROM VACUUM SCIENCE AND TECHNIQUE

Miha Čekada

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Physical vapor deposition (PVD) techniques are a common method of materials science related laboratories. Constructing, say, a magnetron sputtering unit is relatively straight-forward, utilising a vacuum system, a cathode with a respective power supply and a suitable sample holder. Such a unit enables the growth of a high-quality thin film with little lateral variation of properties or other deficiencies.

Unfortunately, upscaling from a laboratory to an industrial system is not trivial. First there are several issues related to cleanliness of the surface: in contrast to laboratory samples, industrial substrates such as machining tools are often contaminated, with difficult-to-clean pockets of volatile agents which can poison the vacuum environment. Complex geometry requires a multiple rotation system to ensure the coating is deposited on all faces; the side effect of such an arrangement is a coating thickness non-uniformity. Another consequence of the complex geometry is the electric field density which locally depends on the substrate shape. In those deposition techniques with a high ionization rate (such as cathodic arc evaporation) this effect strongly influences the local deposition rate. Finally, the emission of microdoplets, dust particles and flakes from previous depositions generates seeds which cause an abnormal local growth of the coating – the growth defects.

In this paper these mechanisms will be discussed in PVD deposition of hard coatings (predominantly transition metal nitrides) at industrial scale. Physical background will be presented first, the intensity of these effects evaluated and methods suggested to limit these influences to a reasonable scale. In a commercial setting these results are often unavailable as they are secret knowledge of the company. In a scientific institute on the other hand, industrially relevant influences can be an interesting topic of research seldom reported in journals. A few cases will be shown how obstacles encountered in industrial deposition can yield high-impact publications. The Department of Thin Films and Surfaces of the Jožef Stefan Institute has been active in this field for over 40 years, thus a hint of a historic perspective will be given as well.



PL-2 FUZIJA, ITER I DONES

Tonči Tadić

Ruđer Bošković Institute, Bijenička cesta 54, Zagreb, Croatia

Fuzija jezgri izotopa vodika – deuterija i tricija – je ono što daje energiju Suncu i drugim zvijezdama. Projekt ITER ("Put" na latinskom) jedan je od najambicioznijih energetskih projekata u svijetu danas i smatra se najsloženijim uređajem u povijesti civilizacije. Njegov cilj je ovladati energijom fuzije, odnosno postići tzv. goruću plazmu, doslovce dobiti komadić Sunca na Zemlji do 2035.



Vrijednost projekta ITER procijenjena je na 15 milijardi €, a u njemu sudjeluju EU, SAD, Rusija, Kina, Japan, Indija i Južna Koreja. Europski dio projekta vodi agencija za fuzijsku energiju Europske Unije, "Fusion for Energy" sa sjedištem u Barceloni. Sam uređaj gradi se u Cadaracheu u južnoj Francuskoj. Znanstvena istraživanja u fuziji za potrebe EU tj. dizajn ITER-a, dizajn fuzijske elektrane DEMO i drugih pratećih uređaja, provodi konzorcij EUROfusion, kojeg čini 28 vodećih instituta iz članica EU, te UK, Švicarske i Ukrajine uz 156 suradnih ustanova, te ukupno više od 2000 znanstvenika.



Cilj DONES-a je omogućiti istraživanje otpornosti fuzijskih materijala na intenzivno neutronsko zračenje. Ovaj 700 milijuna € vrijedan uređaj sastoji se od linearnog akceleratora izuzetne snage koji bi ubrzavao deuterij prema slapu tekućeg litija i tako proizvodio intenzivan snop neutrona za ozračavanje fuzijskih uzoraka. DONES i njemu srodni AFNS u Japanu bi se gradili u suradnji EU-Japan, dok su glavni partneri unutar EU Španjolska i Hrvatska.





Abstracts Keynote Lectures



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KL-1 ANISOTROPY-DRIVEN QUANTUM CRITICALITY IN AN INTERMEDIATE VALENCE SYSTEM

<u>M. S. Grbić^{1,2}</u>, E. C. T. O'Farrell¹, Y. Matsumoto¹, K.o Kuga¹, M. Brando³, R. Küchler³, A. H. Nevidomskyy⁴, M. Yoshida¹, T. Sakakibara¹, Y. Kono¹, Y. Shimura¹, M. L. Sutherland⁵, M. Takigawa¹, S. Nakatsuji¹

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Intermetallic compounds containing *f*-electron elements have been prototypical materials for investigating strong electron correlations and quantum criticality (QC). However, intermediate valence (IV) compounds have been mainly outside the focus of research on QC since the presence of large characteristic energy scales requires application of high magnetic fields or pressures to notably modify their properties or induce new phases.

In contrast, QC has been discovered at zero magnetic field [1,2] in β -YbAlB₄, and at low magnetic field in pure [3] and Fe-doped [4] α -YbAlB₄ systems. Both polymorphs have IV of +2.75 and +2.73, respectively, with a fluctuating valence scale of $T_0 \approx 200$ K.



We present the results of a complete set of thermodynamic, magnetotransport and microscopic experimental techniques used to probe the QC in the pure α -YbAlB₄ and establish a complete picture of the system. The presence of quantum critical properties even in the pure system indicates that YbAlB₄ family is close to several electronic instabilities. The presence of a diverse quantum critical behaviour in the YbAlB₄ family means that a robust physical mechanism emerges in the presence of strong electron anisotropy - unaffected by the change of local

symmetry. By combining the results of complementary techniques we find that the hybridization anisotropy is the key ingredient for achieving QC here. This offers a new route for overcoming the large valence energy scale.

[1] S. Nakatsuji et al., Nature Physics 4, 603 (2008).

- [2] Y. Matsumoto et al., Science **331**, 316 (2011).
- [3] M. S. Grbić et al., in preparation
- [4] K. Kuga et al., Science Advances 4, eaao3547 (2018).



KL-2 THE USE OF GAS CLUSTER ION BEAM IN ASSOCIATION WITH XPS/TOF-SIMS AND TANDEM TOF-SIMS FOR THE ANALYSIS OF ORGANIC/INORGANIC INTERFACES

Matjaž Finšgar

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The use of an argon gas cluster ion beam (GCIB) with adjustable cluster size and acceleration energy, a technology that has only recently been developed and has rarely been used for the analysis of objects, is unique to study depth profiles of organic materials overlying the inorganic materials (for example organic corrosion inhibitors adsorbed on the metallic surfaces). The use of GCIB allows the molecular information to be kept intact. This opens up new possibilities for understanding the structure of materials that have been or are being used. GCIB can be used for both X-ray photoelectron spectroscopy (XPS) and time-of-flight secondary ion mass spectrometry (ToF-SIMS).

Analysis of MS¹ mass spectra of organic materials can be challenging. In addition, when solid materials are analysed without sample pretreatment (this is the usual procedure in ToF-SIMS), adventitious carbonaceous species are adsorbed on the sample surface. The use of tandem (MS/MS) ToF-SIMS allows the determination of analytes with greater confidence for the elucidation of molecular structure. The instrument used has a transmission of more than 80%, which opens new possibilities in analytics. The instrument allows the selection of precursors with a high mass resolution to avoid MS² fragmentation pattern interferences.

The determination of new fragmentation mechanisms is a new contribution to the SIMS database. It should be noted that the databases of SIMS are not rich, and most of the identified species are new to the database of SIMS, which contributes to the fundamental aspects of the SIMS technique.



KL-3 HITCHHIKERS GUIDE TO STRAINTRONICS IN 2D MATERIALS - FRACTIONAL LANDAU LEVELS, ANISOTROPIC BANDS AND INTERACTIONS

<u>Iva Šrut Rakić</u>¹, Preetha Sarkar², Anuva Aishwayia², Predrag Lazić³, Petar Pervan⁴, Marko Kralj¹, Vidya Madhavan² and Nadya Mason²

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Strain engineering of 2D materials has brought a breath of fresh air into this field as it opened up new possible applications including sensors, electrodes, coating, optoelectronics, spintronics and straintronics (strain incorporated electronics). Strained and buckled graphene is particularly interesting as it leads to an appearance of pseudo Landau levels (pLL) and corresponding pseudo magnetic field (PMF) in excess of 300 T, which do not break the time reversal symmetry. In theory, strained graphene should also support fractional quantum Hall phases if Coulomb interactions are introduced, which might allow for superconducting states at 2/3 filling. Furthermore, recently, evidence of flat bands and emergence of correlated states was also experimentally shown in naturally forming buckled graphene superlattices.

Here we show two ways of producing strained graphene with well-defined uniaxial and biaxial periodic modulations, and their resulting changes in electron behavior, a bottom-up and a top-down approach. In the top-down approach laying graphene on a periodic, hexagonal array of 20 nm SiO₂ nanospheres (NSs) deposited on a Si wafer substrate creates a graphene superlattice. Graphene adheres to the underlying pattern and is being stretched, resulting in the change in its electronic structure as compared to the flat graphene on Si wafer. Our scanning tunneling microscopy (STM) and spectroscopy (STS) results show appearance of pLLs as well as fractional pLLs with multiples of $\pm 1/3$. Furthermore, depending on strain size, we observe a splitting of N=0 pLL peak across the graphene on a stepped Ir(332) substrate, investigated its morphology and electronic structure using STM, STS and Angle resolved photoemission spectroscopy (ARPES). Graphene on Ir(332) exhibits drastically changed electronic band structure with Dirac cone anisotropy and alternating p and n doping on reconstructed facets. The DFT calculations revealed the graphene anchoring mechanism via chemisorption at step edges which drives the surface restructuring.

Our findings demonstrate a viable route to alter the electronic structure of graphene by means of strain and substrate interaction and are promising for large-area electronics and optoelectronics applications. Furthermore, this engineered stretching of graphene offers a strategy for creating other superlattice systems for instance with different NS properties or by using structured graphene as a substrate for growing other 2D materials.



Abstracts Invited Lectures



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IL-1 LOW PRESSURE PLASMA FUNCTIONALISATION OF FLUOROPOLYMERS

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Low pressure plasmas are renown as powerful tools for functionalisation polymers. However, surface functionalisation of fluoropolymers with low pressure plasmas of gases such as oxygen, hydrogen, nitrogen, argon, methane, ammonia and others have so far not given satisfactory results, so traditional chemical methods involving the usage of toxic and environmentally harmful chemicals are still used in industry. To address the issue, we have investigated chemical and physical mechanisms of hydrogen (H₂) and oxygen (O₂) plasmas in order to find, if their effects could be combined in the way to achieve the defluorination of the fluoropolymers surface and formation of the hydrophilic functional groups resulting in the increased surface energy and wettability of the surface.

We started with the research of the influence of individual hydrogen plasma species on polytetrafluoroethylene (PTFE). PTFE samples were exposed to either H₂ plasma, to vacuum ultraviolet radiation (VUV/UV) and hydrogen atoms or to only VUV/UV radiation. The F/C ratio of PTFE surface decreased by H₂ plasma to around 0.4 in a second, however at longer treatments it increased again. The treatment with only VUV radiation brakes C–F bonds and decreases F/C ratio to around 0.6 after 7 s. It is interesting that the combination of VUV radiation and hydrogen atoms also decreased F/C ratio to around 0.4 after 6 s. The H-atoms are bind to dangling bonds formed by VUV forming polyolefin-like film on the PTFE surface and also capture released fluorine to HF. PTFE was then further exposed to H-atoms in the afterglow of the E-mode plasma to see if H-atoms alone can cause defluorination. F/C decreased to around 0.6 after 12 s. With optimization of plasma parameters in the H-mode, F/C ratio of 0.2 was achieved. By AR-XPS and extrapolation of F/C ratio at the photoelectrons take-off angle of 0 the F/C ratio of practically zero was found within the surface layer. Complete surface defluorination and formation of polyolefin-like layer was confirmed by SIMS analysis showing appearance of strong $C_x H_v$ ions signals and decrease of $C_x F_v$ ions signals practically to zero. However, water contact angle (WCA) analysis revealed the decrease of WCA from 115° (untreated sample) to only 90°.

To achieve better PTFE functionalisation, we employed O_2 plasma in H-mode for further treatment of PTFE samples previously treated in H₂ plasma. PTFE was exposed to neutral oxygen atoms in the afterglow at three different afterglow distances meaning three different O-atom densities to synthesize oxygen hydrophilic functional groups. At each O-atom density we were changing the O-atom fluence by adjusting the treatment time. Within the O-atom densities range of 2.4×10^{21} to 3.4×10^{21} m⁻³, at the O-atom fluence of around 1×10^{23} m⁻², we were able to achieve static WCAs between 5 and 7°. XPS revealed that oxygen concentration reached approximately 20 at. % after only the shortest treatment pulse of 0.03 s. Interestingly enough, the WCA minimum was not entirely dependent on the surface atomic composition. In the O-atom fluence range between 3×10^{22} to 1×10^{23} m⁻², where the WCA decreased to its minimum, the oxygen and fluorine concentrations remained constant between 20 and 25 at. %. It has been found that functionalisation in the sense of WCA mainly depends on the O-atom fluence (within limited range of O atom densities). If the O-atom fluence was increased to 1×10^{25} m⁻² or above, full hydrophobic recovery was observed and also original chemical



composition of PTFE was restored, which was explained by complete removal of functionalised surface layer by etching.

IL-2 PRESSURE-DRIVEN AND PHOTOCATALYTIC DIVERSITY OF SHAPE-SELECTED ZnO PARTICLES

<u>Martina Vrankić</u>¹, Ankica Šarić¹, Takeshi Nakagawa², Yang Ding², Ines Despotović³, Lidija Kanižaj⁴, Robert Peter⁵, Mladen Petravić⁵, Dirk Lützenkirchen-Hecht⁶

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The physical and chemical features of tuned, shape-selected ZnO particles are discussed in terms of response to external hydrostatic pressure using the Synchrotron Powder X-ray diffraction measurements, degradation kinetics over dye pollutant in aqueous solution and X-ray Photoelectron Spectroscopy fingerprints, latter giving an insight into the morphological versatility and surface diversity of ZnO powder. The microstrain responses of the ZnO NPs to the applied hydrostatic pressure were studied up to 30 GPa, while the photocatalytic reactions were carried over the RhB dye pollutant molecules. We comparatively showed that the diversity of size and shape of ZnO particles distinguishes the wurtzite-to-rocksalt transformation reversibility phenomena by dictating the microstructuredependent deformation behavior and ultimately leads to different microstrain responses to hydrostatic pressure. Moreover, we mimicked theoretical breakthroughs at the Density Functional Theory level leading to morphology-driven ZnO NPs. The exceptionally high apparent-rate constant of $9.7(2) \times 10^{-2}$ min⁻¹ highlights the role of spherical ZnO NPs grown hydrothermally from ethanolic solution towards the giant, spindle-shaped ZnO particles prepared in NaOH medium with calcination treatment. By understanding the crystal growth of ZnO NPs via the molecular ZnO interface/solvent/additive interactions and screening the solution chemistry of ZnO NPs, one can make ZnO a highly efficient promising multifunctional material.



IL-3 MACROSCOPIC SINGLE-PHASE MONOLAYER BOROPHENE ON ARBITRARY SUBSTRATES

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A major challenge in the investigation of all 2D materials is the development of synthesis protocols and tools which would enable their large-scale production and effective manipulation. The same holds for borophene, where experiments are still largely limited to in situ characterizations of small-area samples.1 In contrast, our work is based on millimeter-sized borophene sheets, synthesized on an Ir(111) surface in ultra-high vacuum.2 Besides high-quality macroscopic synthesis, as confirmed by low-energy electron diffraction (LEED) and atomic force microscopy (AFM), we also demonstrate a successful transfer of borophene from Ir to a Si wafer via electrochemical delamination process as illustrated in Fig. 1. Comparative Raman spectroscopy, in combination with the density functional theory (DFT) calculations, proved that borophene's crystal structure has been preserved in the transfer. Our results demonstrate successful growth and manipulation of large-scale, single-layer borophene sheets with minor defects and ambient stability, thus expediting borophene implementation into more complex systems and devices.3

[1] B. Feng et al., Phys. Rev. B 94, 041408 (2016).

[2] K. M. Omambac et al., ACS Nano 14, 7421 (2021).

[3] B. Radatović et al., ACS Appl. Mater. Interfaces, accepted (2022).

Fig. 1. Borophene transfer illustration with comparative AFM images of Bo/Ir and Bo/Si

IL-4 CORROSION CHARACTERIZATION OF TI-6AL-4V ALLOY WITH DIFFERENT TYPES OF BLUE COLOUR SURFACE OXIDATIONS

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Ti-6Al-4V alloy possess high specific strength, good corrosion resistance and biocompatibility which makes this alloy appropriate for the use in medicine for various types of implants. The limitation of use of bare Ti-6Al-4V alloy is possible toxicity of alloying elements such as Al and V when migration of their ions into human tissue occurs. The main trigger of ion migration in this case is corrosion taking place on the surface of this alloy exposed into body fluid. In order to reduce this effect, different types of surface modification of Ti-6Al-4V alloy were proposed and studied in the past, such as physical vapour deposited (PVD) and chemical vapour deposited (CVD) coatings, surface laser modification methods and anodization at different applied voltages in different chemicals.

It is known that certain thickness of titanium oxide will generate certain visible colour because by interrupting the light waves when they pass through the oxide and reflect off the metal surface.



Despite of the same thickness of the oxide, corrosion resistance of titanium oxidised by different techniques is not the same, so it is obvious that thickness of the oxide is not the only parameter that influence corrosion resistance.

In our investigation we have focused on comparison of corrosion properties of oxides of blue colour applied to the surface of Ti-6Al-4V alloy by different techniques: plasma oxidation, laser surface treatment and electrochemical anodization. Corrosion measurements were conducted in 0.9 % NaCl simulating body fluid. These were open circuit potential measurement, linear polarisation, electrochemical impedance measurements and potentiodynamic polarisation. In addition, surface and subsurface characterization was performed by XRD, XPS and metallographic method. All investigations were conducted also on bare Ti-6Al-4V alloy which was used as reference material for the comparison.

It was observed that some of applied surface treatment improve, and other worsen corrosion resistance. Corrosion selection can thus narrow the range of surface oxidations, in which also other important target properties such as osteointegration, binding of different cells to the surface, thrombogenicity, etc. are needed.

IL-5 CAPABILITIES OF THE ION BEAM MICROPROBE AT THE RUÐER BOŠKOVIĆ INSTITUTE

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All the analysis techniques involving energetic ion beams, known as IBA techniques, constitute the workhorses of MeV accelerator-based facilities. However, in several applications, where the use of ion beams of micrometer dimension is required, it is not possible to simply reduce the size of the beam using collimators. Throughout the last decades, there was substantial progress in the development of focused MeV ion beams using electrostatic/magnetostatics lenses, known as an ion beam microprobe system. Nowadays this system has become key in a broad range of fields like materials science, nuclear physics applications, and electronic technologies. Under operation since 1991, the ion beam microprobe of the laboratory for ion beam interaction (LIBI) at the Ruder Bošković Institute (RBI) has evolved into one of the most powerful analytical tools, suitable for the application of almost all available IBA techniques [1]. Linked to the RBI particle accelerators, a good selection of ion species and ionization profiles can be provided, from protons (0.4 to 8 MeV) to most of other heavier ions up to ME/q² ratio of 15 MeV. The focused ion beam can be scanned over the sample surface under analysis (typically up to $1 \times 1 \text{ mm}^2$) and the synchronization with the acquisition system can provide 2D elemental mappings with an excellent spatial resolution (micron and sub-micron scales). This contribution will provide an overview of the state of art of the P-probe beamline at RBI and the most recent experiments. This review will outline the µ-PIXE and 2-NRA techniques and their application for the morphological analysis and quantification of the concentration of low Z elements presented in dust particles from the tiles of the ASDEX Upgrade tokamak. Another widely applied technique is the IBIC used to perform the study of the charge transport properties of radiation detectors (diamonds, LGADs, ...) and other electronic devices [2, 3]. The IL experimental setup using the D-probe plays an important role in the characterization of the luminescence properties, the kinetics of damage, and the thermal resistivity of scintillators materials using different ion species and temperatures to mimic the working conditions of a nuclear fusion reactor. In addition, the STIM technique offers the opportunity to



measure the stopping power in diamond for protons at the MeV energy range. Finally, one of the most interesting applications is the High-resolution PIXE spectrometry. Based on the application of Bragg's law using a diffraction crystal and a position-sensitive CCD X-ray detector, this technique offers an excellent energetic resolution compared with standard PIXE. The high potential of this technique was used for the examination of the influence of multiple ionization satellites induced by 3-5 MeV energy helium ion beams on the analysis of X-ray spectra obtained by the APXS spectrometer of the Curisosity Mars rover.

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IL-6 MAGNETRON SPUTTERING DEPOSITION OF GE BASED CORE/SHELL QUANTUM DOT LATTICES IN ALUMINA MATRIX

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In this study, we demonstrate the production of thin films made of 3D-ordered core/shell quantum dots embedded in an alumina matrix. The films were produced by a magnetron sputter deposition, by virtue of a self-organized growth regime. The Ge core size was tuned by varying the Ge-layer deposition time while the other parameters were kept constant. The influence of an additional shell and Ge core size on the structural, optical, and electrical properties was investigated. The results confirm the formation of core/shell quantum dots, differing by the sizes of the core and shell, that are arranged in a 3D-ordered network. The optical properties of the materials, their photo-generation ability, and quantum efficiency show a strong dependence on the Ge core and shell size. Also, the material's bandgap is strongly tuneable by the size of the Ge core, and by the presence of the shell. The investigated materials are very promising for application in solar cells, photodetectors, and sensors.



IL-7 NOVEL IONIZATION GAUGE WITH A STRAIGHT-PATH ELECTRON BEAM

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A novel design for an ionization gauge was proposed in the scope of the European project EMPIR 16NRM05. The goal of this project was to develop a stable ionization gauge, which would be suitable as a reference standard in vacuum metrology. The proposed design of the gauge ensures a straight path of the electron beam, resulting in a very well-defined ionization length. This, in turn, results in well-defined sensitivity of the gauge. Nitrogen sensitivity was determined for 10 gauges made by two manufacturers, and was within 2.5% for all gauges. In addition to this, change of sensitivity over the pressure range from 1×10^{-6} Pa to 1×10^{-4} Pa was found to be below 0.4%.

The gauge utilizes a Faraday cup into which the electron beam is deflected after leaving the ionization volume. The cup is positioned in such a way that X-rays, created when the electron beam hits the cup, cannot collide with the collector rod of the gauge. This setup results in a pressure resolution of the gauge to about 2×10^{-9} Pa.

The robust design of the gauge makes it resistant to damage and, with it, to change in sensitivity during transport of the gauge. Drop-down tests, made by dropping the box with the gauge inside from a height, resulted in the change of sensitivity below 0.6%.

The proposed design of the ionization gauge was shown to be successful in achieving the goals set by the European project. Well-defined sensitivity of the manufactured gauge means that without calibration its uncertainty is within 5%, which enables the user to save on calibration costs, and its robust design ensures good stability of the sensitivity.

IL-8 TOWARDS THE FIRST STRONTIUM OPTICAL ATOMIC CLOCK IN CROATIA

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Development of atomic clocks has enabled technological and scientific advances like Global Navigation Satellite Systems, very-long-baseline interferometry, tests of general relativity and of the time-variation of fundamental physical constants, with further proposals for their use for the detection of dark matter and gravitational waves. The advent of optical frequency combs two decades ago has enabled improvements in the accuracy and precision of atomic clocks of over two orders of magnitude by enabling practical measurements of optical clock transitions. Strontium is often used in such optical atomic clocks, with current state-of-the-art clocks reaching a level of stability of $10^{-17}\tau^{-1/2}$ and a level of accuracy bellow 10^{-18} [1].



At the Institute of Physics, within the project Center for Advanced Laser Techniques (CALT), http://calt.ifs.hr/, the infrastructure for the construction of the first optical clock, not just in Croatia, but also in the wider area of South-Eastern Europe, has been provided.

The vacuum system for our experiment is designed specifically to meet the needs of the future strontium clock: long vacuum lifetime and homogeneity of the black-body radiation background. In our experiment hot strontium atoms leaving an effusive oven will first be transversely cooled and then slowed down by using a Zeeman slower. Next, they enter a 2D magneto-optical trap (MOT) chamber and are pushed to a 3D-MOT chamber under a 45° angle relative to the entering direction. This way, uncooled atoms of the atomic beam do not enter the 3D-MOT chamber, the Zeeman slower beam is prevented from crossing the 3D-MOT and atoms in the 3D-MOT chamber are not affected by black-body radiation from the oven. In the 3D-MOT chamber, a blue and red 3D MOT will be used to cool down the atoms. Once cooled to approximately 1 μ K, atoms will be loaded into optical tweezers or a multiplexed 1D lattice. These trapped atoms will be used for high-resolution spectroscopy on the strontium clock transition.

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IL-9 MULTIMATERIALS BASED ON LOW TEMPERATURE PLASMA GROWN GRAPHENE AND LASER PRODUCED METAL AND METAL OXIDE NANOPARTICLES

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The interest in novel, often carbonaceous materials with large effective surfaces, as well as high conductivity and stability, is growing due to the downsizing of electrical devices and the demand for low-cost new materials. In particular, we present a work on a graphene- metal or metal oxide multimaterials. This type of nanomaterials shows great potential applications for electrochemical devices, transistors, batteries and biosensors. In this work the techniques used for the production of these multicomponent materials are presented: synthesis of 2D vertically aligned graphene by plasma on uniquely low temperatures, and deposition of metal and metal oxide nanoparticles and thin layers from different pulsed laser deposition procedures. The chemical and microstructural features are revealed by employing Scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS), and Near edge X-ray absorption fine structure (NEXAFS) spectroscopy. Measurements were done at the HE-SGM beamline at the synchrotron radiation facility BESSY II in Berlin (Germany). NEXAFS is a unique method to obtain information on the surface region of the sample (bonding states, fingerprint of materials). XPS in this specific case can be used with variable excitation energies to enhance surface sensitivity and excitation cross-sections.

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Helmholtz Zentrum Berlin for the allocation of synchrotron radiation beamtime at BESSY II. Experiments at BESSY have been also supported with H2020 Calypso Plus project, grant Nr. 221-11233-ST and 212-10721-ST.

IL-10 MONTE CARLO SIMULATIONS OF SPUTTERING YIELD FOR DEPOSITION-RELEVANT TARGET MATERIALS Nastja Mahne^{1,2}, Miha Čekada¹, Matjaž Panjan¹

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Sputtering is a physical process in which atoms are released from a solid when high-energy ions collide with the material. It is essential in many technological and analytical techniques. In sputter deposition techniques, thin films are produced by sputtering while in analytical techniques, sputtering is a part of the ion etching process used for compositional depth profiling. Sputtering yield is defined as the number of sputtered atoms per impinging ion. It depends on the energy, mass and impact angle of the incident ions and on the target material. Accurate sputtering yields are required for process control in thin film deposition, modelling of discharges, and in techniques where ion etching plays a central role. Here we present Monte Carlo based simulations used for evaluation of sputtering yields.

In practice, two approaches are used to simulate sputtering process. The first method called *molecular dynamics simulations*, takes into account the interactions between all particles in the solid. Such simulations offer a very accurate insight into evolution of atom positions as the ion moves through the solid; however, they are less useful for calculating sputtering parameters. They are computationally demanding and only a limited number of impinging ions can be simulated. The second type of simulation methods is based on the *binary collisions approximation* (BCA), which takes into account only the interactions between the particles involved in the collisions. Typically, the Monte Carlo method is used to select random variables associated with the stochastic particle collisions. This simulation approach is simpler and less computationally demanding; as a result, it enables calculations of a large number of impinging ions and thus provides better statistics for evaluating sputtering yield and other parameters.

In this work, we calculated the total and differential sputtering yields using a BCA/Monte Carlo simulation program called SRIM (Stopping and Range of Ions in Matter). The simulations were made using Ar ions with energies up to 1200 eV impinging on various deposition-relevant target materials (B, C, Al, Si, Ti, V, Cr, Cu, Zr, Nb, Mo, Ag, Hf, Ta, W, Au). We investigated sputtering yields in dependence of ion energy, incident angle and target material. The total sputtering yield is not a linear function of ion energy, rather it increases with an exponent of 0.6–0.7 (i.e., for energies up to 1200 eV). A cosine angular distribution of atoms was observed for practically all investigated materials. The sputtering yield does not change substantially for ion angles below ~30° against the surface normal. Above this incident angle, it starts to increase and reaches peak at the angle of about 70°. For the transition metal elements, the total sputtering yield increases with the increasing group of the periodic table. Elements with the lowest sputtering yields are in group 4 (i.e., Ti, Zr, Hf) while the elements with highest sputtering yields are in group 11 (i.e., Cu, Ag, Au).



IL-11 SURFACE TREATMENT OF LIGNOCELLULOSIC MATERIALS WITH DIELECTRIC BARRIER DISCHARGE IN CONFIGURATION WITH FLOATING ELECTRODE

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Lignocellulosic materials can be treated with various techniques and processes to activate their surfaces and improve their ability to be coated or bonded. A novel device for generating a non-thermal dielectric barrier discharge in a floating electrode configuration has been developed for the pretreatment of solid wood and other lignocellulosic materials. The contribution presents the influence of various parameters of the plasma treatment process on the properties of the treated surfaces and their interactions with the applied water-based coating and adhesives. It was found that the properties of the generated plasma discharges depend on the inherent properties of the substrates and the set treatment parameters. Treatment of fresh and aged or weathered wood surfaces with plasma leads to their oxidation. This also leads to increased surface free energy of the wood surface, its improved hydrophilicity and wettability with coatings and adhesives. The improved adhesion of water-based coatings and adhesives were obtained after treatment of natural wood, thermally modified wood, medium-density fibreboard and particleboard. The studies have shown that this type of pre-treatment is a good alternative to conventional surface treatment processes.

IL-12 BIOELECTRONIC INTERFACES BY PVD OF SEMICONDUCTING ORGANIC PIGMENTS

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Effective and localized, minimally invasive, and physiologically stable wireless electrostimulation capability would present a valuable tool both in research, as well as in the development of bioelectronic therapies, neural prostheses such as artificial retinas, artificial limbs, auditory prostheses, and brain-machine interfaces. High quality thin films of semiconducting organic pigments can easily be deposited by thermal vacuum evaporation. Such films have shown excellent stability in aqueous environment, either in form of single thin films or as a part of functional devices, such as transistors and photodiodes. We will discuss a family of self-contained photo-capacitive devices for effective wireless bioelectronic stimulation based on a bilayer of organic pigments, metal-free phtylocyanine (H₂PC) and N,N'-dimethyl perylenetetracarboxylic diimide (PTCDI) as the active materials - organic electrolytic photocapacitors (OEPC). OEPC devices have demonstrated effective, chronic and localized in-vivo wireless peripheral nerve electric stimulation¹. We will show how spatial structuring of the OEPC's affects their optoelectronic² and bioelectronic properties, demonstrated by the results of the



FEM numerical modelling and measurements of spatial transductive extracellular electric potential field maps.

This work has been supported by Croatian Science Foundation under the project UIP-2019-04-1753. We acknowledge the support of project CeNIKS co-financed by the Croatian Government and the European Union through the European Regional Development Fund - Competitiveness and Cohesion Operational Programme (Grant No. KK.01.1.1.02.0013), and the QuantiXLie Center of Excellence, a project co-financed by the Croatian Government and European Union through the European Regional Development Fund - the Competitiveness and Cohesion Operational Programme (Grant KK.01.1.1.01.0004). Financial support by the Center of Excellence for Advanced Materials and Sensors, Croatia, is gratefully acknowledged.

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IL-13 IRREVERSIBLE THERMOCHROMICS AND THE NEED OF VACUUM-RELATED TECHNOLOGIES

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Most commercial thermochromic materials change colour reversibly and are commonly used for commercial and decorative purposes. More interesting applications are possible when the colour change occurs only once and remains practically permanent. Such materials can be used as temperature indicators to show whether the temperature of objects has reached a target value. Such applications are among the challenges in technology and are also important in everyday life. Some goods need to be stored below a certain temperature to protect them from spoilage, while others need to be heated properly to develop the desired properties. The solution is not straightforward, as the options for controlling the surface temperature of items are limited and/or unsustainable.

Our aim is to develop thermochromic inks and use them for printing labels that can be used as temperature indicators. Purely organic, thermochromically active materials are being developed that change colour at a desired temperature, somewhere in the wide temperature range. Reversible and irreversible versions are possible. The irreversible versions are our innovation and are shown here.

Unique thermochromic materials are used as an active ingredient in printing inks. To be as environmentally friendly as possible, no hazardous substances are used and the inks are water-based (without VOC). This goal brings many challenges, especially because the special thermal properties of the ink have to be considered. Most of these are related to the requirements of the printing industry,



which has to accept printing with water-based inks, which tend to adhere less well to most substrates and have to dry for longer. The first particular challenge is drying at a low temperature to avoid discolouration and to be as fast as necessary in roll-to-roll application. The next challenge is to achieve good adhesion of the water-based inks, even on substrates that are not prepared for printing purposes. The challenges are solved by using vacuum-related technologies.

IL-14 HYBRID METAL NANOISLANDS AS PLASMON-BASED SENSORS

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Due to the interplay of localized surface plasmon resonance (LSPR) and their distinct shape, hybrid metal nanoislands show great promise as sensors, both in plasmonic sensing and surfaceenhanced Raman spectroscopy (SERS). Optimal sensors would exhibit the strength of LSPR matching that of pure silver nanoparticles, and the stability matching that of pure gold nanoparticles. We have prepared hollow metal nanoislands controlling their morphology and optical properties utilizing galvanic replacement and Kirkendall effect with a relatively simple procedure. Silver nanoisland thin films were prepared on glass substrates by physical vapour deposition and subsequent heating, after which they were treated with different amounts of tetrachloroauric acid. By increasing the amount of tetrachloroauric acid, the plasmon resonance was shifted starting from blue, through the whole visible range, and ending in the near infrared range. SERS measurements show that such nanostructures are suitable for enhancing Raman scattering, but the explanation for the observed enhancement as a fuction of acid amount was not obvious. Through the combination of experimental techniques and modeling, the Raman enhancement trend was explained taking into account the combined influence of treatment and ageing on the optical properties, which were, in turn, explained by the morphological changes. Stability of the samples was shown to be of paramount importance and the optimal combination of stability and LSPR strength is highlighted.



Abstracts

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https://www.kobis.hr/



P-1 SURFACE MODIFICATION OF METALLIC BIOMATERIALS

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Metallic materials have been widely used for biomedical applications, however they still lack of desired biocompatibility. In order to improve bio-performance of metallic materials, various surface modification techniques have been applied. Herein, hydrothermal technique and electrochemical anodisation as well as non-thermal plasma treatment are presented as techniques for modification of morphology, surface chemistry and wettability of Ti-based surfaces. Alteration of physicochemical properties resulted in the selectivity of cell (platelets, endothelial smooth muscle) adhesion to modified surfaces. Specifically, the nanostructurization, combined with oxygen plasma treatment enabled the formation of a surface with characteristics, especially appropriate for use as vascular stents.

P-2 INFLUENZE OF AG-DOPANT RATIO ON PHOTOCATALYTIC PERFORMANCE OF LASER-SYNTHESIZED ZNO NANOPARTICLES

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In this work, Ag-doped ZnO nanoparticles are synthesized by using two-step laser synthesis. First, pulsed laser deposition (PLD) is used for deposition of Ag films on ZnO substrate. Such synthesized ZnO substrate covered with Ag layer is than put in the water in order to produce colloidal solution of Ag-doped ZnO nanoparticles by pulsed laser ablation in liquid (PLAL). Nd:Yag laser (pulse repetition 5 Hz, pulse duration 5 ns pulse duration, wavelength 1064 nm, single laser shot energy 300 mJ) was used for irradiation of targets in PLD and PLAL process [1]. In order to vary the Ag ratio in ZnO nanoparticles with different Ag ratio, different number of pulses (50, 200, 500, 1000, 2000 and 3000) were used in PLD for Ag deposition. The ratio of Ag dopant in ZnO nanoparticles strongly depends on the thickness of Ag layer at ZnO target. In each of six synthesized colloidal solutions Ag weight ratio is calculated using the data obtained by two various techniques, ICP-OES and XPS, while their photocatalytic performance is tested for degradation of Methylene Blue under UV irradiation. Various experimental techniques (XRD, XPS, SEM, UV-Vis) were used to determine the crystall structure, size-distribution



and optical properties of Ag-doped ZnO nanoparticles. In this work we discuss the dependence of MB photodegradation rate on Ag-dopant ratio calculated from both methods, ICP-OES and XPS. Ag-doping is shown to increase the MB photodegradation rate about two times twice at 0.32 wt% of Ag in ZnO (calculated from ICP-OES).

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P-3 SELF-ASSEMBLED AG NANOPARTICLES IN SIC MATRIX

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We explore production of self-assembled Ag nanoparticles in SiC matrix by magnetron sputtering multilayer deposition. Different deposition temperatures and different multilayer compositions are used to obtain the self-assembling growth mode. In addition, the materials are annealed at different temperatures up to 500 °C after the deposition.

We show that the ordered lattice of Ag nanoparticles is already formed during the deposition at room temperature. Higher deposition temperatures lead to larger Ag nanoparticles. The investigated materials show the Ag surface plasmon resonance peak in optical properties, and its position and width depend on the deposition and annealing conditions.

P-4 ADVANCED QUANTITATIVE ANALYSIS OF COLLOIDAL SOLUTION OF METAL NANOPARTICLES PRODUCED BY LASER ABLATION IN LIQUIDS

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The diameter of laser synthesized colloidal nanoparticles can be derived from a volume of ablated material and absorbance at surface plasmon resonance (SPR) wavelength. The origin of such nanoparticles' diameter has been studied in detail. The study is based on Beer-Lambert law where nanoparticle size-distribution and UV-Vis photoabsorbance data are completely exploited. Theoretically modeled diameter is verified by independent integral approach proving that simple analytical model based on equivalence of absorbance concentration and volume concentration is by most means usable for determination of diameter of laser synthesized nanoparticles in colloidal



solution with sizes less than SPR wavelength. Mathematical proof that diameter obtained by simple analytical model is in fact mode diameter (most frequent diameter) of size-distribution in monodisperse limit is also presented. Furthermore, relation between mode, volume average and number average diameter of nanoparticles has been found under specific definition of number concentration of nanoparticles in colloidal solution. It is shown that mentioned diameters are not mutually independent but dependent on standard deviation of log-normal size-distribution. This is verified for size-distributions obtained independently by AFM, TEM and DLS techniques and is proposed to be universal property of log-normal size-distribution function. Since derived model is based only on two relevant experimental parameters: SPR absorbance and volume of ablated crater, it makes electron microscopy unnecessary for nanoparticles' size determination.

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P-5 DETERMINING NEUTRAL ATOM DENSITY AND RECOMBINATION COEFFICIENTS USING CATALYTIC TUBES IN LOW-PRESSURE MICROWAVE-GENERATED PLASMA

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Heterogeneous surface recombination of neutral atoms was studied in a low-pressure microwave-generated plasma system. Plasma was discharged inside a narrow quartz tube, which was connected to a wider afterglow chamber consisting of borosilicate. Measurements using a catalytic tube connected to a thermocouple were done in the afterglow chamber, therefore minimizing the effect of ions on our measurements. In principle, all neutral atoms should have recombined on the catalytic tube, giving us a neutral atom density value completely independent of the recombination coefficient. This was confirmed by placing a standard catalytic probe behind the catalytic tube and measuring plasma density. Different catalytic tubes were used to confirm the calculated neutral atom density. After obtaining neutral atom densities for hydrogen, oxygen, and nitrogen at different pressures, the catalytic tube was replaced with a standard catalytic probe. Neutral atom density under the same conditions was measured with two catalytic probes, one with a nickel tip and one with a cobalt tip. The recombination coefficient of the probe tip was calculated using the measurements with the catalytic tubes and the measurements with the catalytic probes. Results show a pressure dependence of the recombination coefficient for both nickel and cobalt, with the recombination coefficient increasing with pressure until reaching a maximum and then decreasing at higher pressures. Further studies are required to determine the underlying mechanisms.



P-6 BULK-LIKE THIN FILMS OF BLUE BRONZE

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Thin films of blue bronze ($K_{0.3}MoO_3$) was grown by pulsed laser deposition on Al₂O₃ (1-102) and SrTiO₃ (510) substrates. Structural and imaging characterization revealed good quality films with well oriented grains of few microns in length. Both transport and femtosecond pump-probe spectroscopy probes revealed charge density wave properties that are very close to those of the bulk crystals. Comparison with films with smaller grains is also shown.



Figure 1 AFM images of film on ALO (left) and STO substrates.



Figure 2. Left: comparison of resistance of with long (BB3ALO and BB3STO) and short (BB2STO) grains and single crystal samples in Arrhenious plot. Right: "logarithmic derivative" of long-grain point to slightly lower T_P and the same temperature dependence compared to single crystal down to 40 K



P-7 COMPARISON OF WEAR OF PVD COATINGS AT DIFFERENT SLIDING CONTACTS

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PVD hard coatings are used to improve wear and frictional properties and therefore extend the cutting tool life. One of the main criteria for the tool life is tool wear, which is usually caused by different mechanisms. Wear behaviour of coated and uncoated tools was studied using pin-on-disc wear test procedures. For pin-on-disc wear tests an uncoated ball, sliding on a coated or uncoated disc is commonly used and disc wear parameters (cumulative weight loss, average surface roughness and wear rate) are then analysed. However, in real applications, the workpiece is uncoated and the tool edge, which can be coated, is sliding on the workpiece surface. Therefore, in order to simulate conditions closer to the real cutting process, a coated ball and an uncoated disk should be used and wear analysis should be done on the ball. However, wear on a round surface is difficult to analyse, so wear on the flat disc is commonly determined. This experimental research is focused on the pin-ondisc wear tests, where pin and disc are made from the same material (WC-Co – cutting tool material). To compare both pin-on-disc procedures, tests were performed using a coated ball (6 mm) sliding on the uncoated disc and vice versa, an uncoated ball sliding on the coated disc. In both procedures, wear on the disc is determined. For this experiment TiAlSiN, AlTiN (performed in an industrial CemeCon CC800/9 magnetron sputtering machine) and TiAIN (performed in an industrial Kobelco AiPocket cathodic arc evaporation machine) PVD hard coatings were used, respectively.

P-8 TOF-SIMS 3D ANALYSIS OF SOLAR CELLS

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Time-of-flight secondary ion mass spectrometry (ToF-SIMS) is a very versatile surface-sensitive mass spectrometry method regarding the type of data that can be acquired. Measuring mass survey spectra, we analyse the sample surface and determine different ions through their *m/z* values as well as their intensities. SIMS depth profiles offer us the possibility of studying the bulk of the sample by removing consequent layers of the material. 2D SIMS micrographs reveal the distribution of different compounds on the surface by mapping the positions of the rastering ion beam that we use for the analysis. Finally, we can combine 2D imaging and depth profiling to reconstruct the 3D chemical structure of the sample. In this process, we build a 3D cube composed of the voxels that represent mass spectra in the specific point of the space, dependent both on the lateral coordinates as well as on the depth where it was acquired.



3D ToF-SIMS analysis is the most useful when analysing samples composed of chemically different layers that have, at the same time, also a heterogenous lateral distribution of compounds. Examples of such samples are solar cells which are initially built from different layers of inorganic and, in some cases, organic compounds. Furthermore, either during the preparation of the cell or its working cycle, the heterogeneities in the lateral distribution of these compounds can arise. We were recently studying two types of solar cells, one fully operational while the other in the development, where 3D sample reconstruction using ToF-SIMS gave us some critical information. In the case of the already developed perovskite-solar cells, we mainly studied the diffusion of sodium from the underlying glass and discovered that Na+ ions migrate only locally in the form of the channels [1]. We also studied the novel combinations of the mixed organic donor and acceptor compounds deposited on the ITO substrate and, in some cases, found very clear heterogeneities in their lateral distribution.

Nevertheless, ToF-SIMS 3D depth profiling is of course applicable to many other fields and not just photovoltaics. It can be applied whenever we are simultaneously interested both in the lateral and depth chemical composition of our sample, regardless of compounds being organic, inorganic, or mixed.

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P-9 2D BORON ON IR(111): LARGE-SCALE GROWTH AND PHOTOEMISSION STUDY

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Large-scale growth and the investigation of the electronic structure of 2D materials are crucial for their tailored design and understanding of their physical properties. Since the first experimental realization of 2D epitaxial boron (*i.e.* borophene) on Ag(111) in 2015 [1], there has been a growing interest in finding alternative routes to its synthesis [2] and revealing the morphology and properties of different polymorphs. This also includes examination of borophene-substrate interaction, as well as interaction with other atoms and molecules which may be used for functionalization of borophene. The metallic character of borophene renders the material a potential conductive layer in future flexible electronics.

Here, we showcase our experimental results on segregation-enhanced epitaxy of borophene on Ir(111) and its photoelectron spectroscopy characterization. Employing borazine as a precursor, we grew millimetre-sized borophene monolayer on Ir(111) exhibiting a (6×2) superstructure (the χ 6-polymorph), evidenced by the low energy electron diffraction (LEED) pattern, low energy electron microscopy (LEEM) images [2] and atomic force microscopy (AFM) data. We present our results on surface mapping with *in situ* ARPES and XPS which demonstrate noticeable changes in the electronic structure of Ir(111) and emergence of characteristic B-related electronic levels after the borophene growth. The study provides guidelines for the examination of structure and stability of borophenes grown on metallic substrates in an ultra-high vacuum (UHV) environment. References

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P-10 LINEAR MAGNETOELECTRIC EFFECT IN MULTIDOMAIN ANTIFERROMAGNET Cu3TeO6

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The family of antiferromagnets (AFM) with multidomain structure is of particular importance in the fundamental research of multiferroics because they represent an opportunity to examine the dynamics of domains and domain walls, their motion, creation, or destruction, as well to examine the role of magnetoelectric (ME) effect [1,2]. A member of the mentioned family is copper tellurium oxide, Cu3TeO6, which has a cubic crystal structure (Fig 1) with a three-dimensional magnetic lattice in which copper ions form hexagons with shared vertices [3,4]. Below TN = 61 K AFM order with multiple domains develops (Fig 1) with an easy axis pointing along one of the space diagonals of the cubic unit cell, resulting in 8 (4x2) AFM domains [4].

Figure 1 Crystal structure of Cu3TeO6 along different directions is shown on (a) and (b). 8 domains created by the copper planes oriented perpendicular to the space diagonals are shown on (c) [5]

To investigate ME properties in Cu3TeO6 we performed static electric polarization measurements, dynamic dielectric spectroscopy studies and magnetic measurements in an external magnetic field up to 16 T for a few different directions of electric polarization and magnetic field. The polarization increases as the magnetic field increases when the electric and magnetic field are mutually perpendicular (at least up to 12.8 T), but the observed ME effect is not in agreement with the symmetry-determined ME tensor. There are two possible explanations for that observation. The actual symmetry of the ordered state is different than what is proposed in neutron diffraction experiment [4], or spin reorientation within each domain takes place. We analyze both of these possibilities and look into possible presence of ferrotoroidal order in investigated material. However, additional experimental and theoretical studies are still needed to further understand the origin of linear ME coupling and the role of quantum effects in this material.

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P-11 GDOES, ToF-SIMS AND XPS DEPTH PROFILING OF POLYAMINE FILMS

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GDOES, XPS and ToF-SIMS depth profiling was compared on the thin polymer films of thickness of 70 nm and 500 nm and deposited by PECVD from a cyclopropylamine precursor [1]. These depth



profiles were evaluated in terms of sputtering rate, depth resolution, sensitivity and artefacts. The GDOES depth profiling was considered in more details involving the erosion of the polymer films in an asymmetric RF capacitively coupled discharge using both Ar and Ar-O₂ gases. The application of pure Ar caused unwanted effects, such as the broadening of the polymer-film/substrate interface, which were suppressed when using the mixture with oxygen. Another benefit of oxygen for GDOES was a significant increase in the etching rate by a factor of about 15 as compared to pure argon. The mechanisms involved in the depth profiling using the mixture of gases were elaborated in some detail, taking into account plasma parameters typical for an asymmetric, capacitively coupled RF discharge in a small volume. The main benefit of using the Ar/O₂ GDOES profiling with respect to XPS and SIMS depth profiling is the increased sputtering rate for polymer films. Comparing the GDOES depth profiling with the Ar/O₂ mixture with profiling in pure Ar, the benefits are a higher sputtering rate and better depth resolution at the polymer/substrate interface.

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P-12 LASER SYNTHESIS OF NANOPARTICLES: APPLICATIONS AND PERSPECTIVES

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Plasma technologies today are taking attention in the development of emerging advanced materials of new generation due of its unique properties, broadness of applications and effectiveness of treatment. Plasma processing of materials is increasingly used in industrial, technological and medical applications. This work is based on innovative laser synthesis of colloidal nanoparticle solutions and their applications. Laser synthesis of nanoparticles is based on a process of laser ablation of metallic or metal-oxide targets immersed in liquids and it is known as 'green' and versatile synthesis route (no chemicals involved in the synthesis) allowing synthesis of pure nanoparticles of wide variety of materials. Nanoparticle applications to be discussed:

- Metal oxide nanoparticles as solid contact in ion-selective electrodes sensitive to potassium ions

- Controlling the composition of plasma-activated water by Cu ions



- Bacteria Exposed to Silver Nanoparticles Synthesized by Laser Ablation in Water: Modelling E. Coli Growth and Inactivation

- Photodegradation of Methylene Blue and Rhodamine B Using Laser-Synthesized ZnO Nanoparticles

P-13 ION IRRADIATION INDUCED DAMAGE PRODUCTION IN GRAPHENE

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For successful exploitation of graphene application potential in different fields of nanoscience and technology, the control over its unique properties is neccessary¹. Two-dimensional graphene properties are sensitive to defect environments² and by using ion beams, one can successfully tune its properties for desired applications. Moreover, ion beams provide a clean and precise tuning approach in nanometre dimension in comparison to chemical and other routes. In the present experiment, defect engineering of few-layer (2-4 layer) and bilayer graphene is studied by using 5 different ion beams keeping in mind the energy deposition of these beams into graphene lattice. Three ion beams (60 MeV Si, 60 MeV Ti, and 70 MeV O) are used for few layers' graphene and two other beams (23 MeV I and 100 MeV Ag) are used for bilayer graphene structural investigation. In order to assess the structural stability of atomically thin graphene under ion irradiation, we chose a wide range of ion fluences ranging from 3×10^{10} ions/cm² to 1×10^{14} ions/cm². Raman measurements are done before and after ion irradiation on graphene sample and intensity ratio of D and G Raman peaks are plotted with respect to the ion fluence. In the case of few-layer graphene, defect annealing is reported at very low ion fluences up to 3×10^{11} ions/cm², whereas a linear increase in defect density is observed in the medium range fluence up to 3×10^{13} ions/cm². At the highest applied ion fluence used in the study (1 \times 10¹⁴ ions/cm²), graphene is amorphized and a decrease in ID/IG ratio is reported. A similar observation is made in the case of bilayer graphene. Three different fluence regions are discussed with the help of models proposed by Kumar et al³., Lucchese et al⁴. and Ferrari et al⁵.

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P-14 3D NETWORK OF AU NANOPARTICLES IN MOO3 MATRIX

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We explore 3D networks of Au nanoparticles formed in MoO₃ matrix by magnetron sputtering deposition of (Au+MoO₃)/MoO₃ multilayer, followed by thermal annealing. The deposition conditions leading to the self-assembling growth mode of Au nanoparticles are investigated, including deposition temperature and the thickness of individual layers in the multilayers. We show formation of 3D network of Au nanoparticles ordered in a body centred tetragonal (BCT) lattice. The formed Au nanoparticles under various deposition conditions differ by their size and separation in the MoO₃ matrix. The structural properties obtained during the film growth is found stable for annealing up to 300°C. Optical properties of the films are determined and the surface plasmon resonance of Au nanoparticles is observed. The peak positions are found dependant on the structural properties (size and separation) od Au nanoparticles, and the annealing conditions.

P-15 KINETICS OF POLYMER SURFACE FUNCTIONALIZATION UPON TREATMENT WITH OXYGEN ATOMS

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The surface functionalization of polymers with polar groups remains a subject of academic research despite the broad application of plasmas for tailoring surface properties of polymer materials in the industry. A scientific challenge is the explanation of the surface reactions on the atomic scale and the technological functionalization with a desired functional group. Namely, plasma treatment usually causes the formation of various functional groups of unpredictable concentrations. Time-evolution of functional groups was investigated during the initial stages of surface oxidation of polystyrene. The polystyrene samples were treated by O-atoms from a remote microwave source. The experiments were performed in a preparation chamber attached to the ultra-high vacuum chamber of the XPS spectrometer. The samples were treated with a suitable fluence of O-atoms and characterized without breaking vacuum conditions. The hydroxyl groups appeared on the surface at low fluences, while carboxyl or ester groups were observed after receiving the O-atom fluence of approximately 1×10^{22} m⁻². The destruction of the aromatic rings occurred after the surface saturation with hydroxyl groups. Prolonged treatment caused over-saturation of polystyrene with polar groups, which was attributed to the laterally inhomogeneous etching and thus increased roughness on the nanometer scale.



P-16 UNCONVENTIONAL TEMPERATURE SHIFT OF QUANTUM-OSCILLATION FREQUENCY IN TOPOLOGICAL INSULATOR BISBTE₂S

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BiSbTe₂S doped with Sn is believed to be the "perfect" topological insulator [1] with the Fermi energy located in the energy gap. In our samples, we observed well-pronounced quantum oscillations (QOs) that survive up to 30 K. Measuring the QOs at different temperatures, we observed the shift in the frequency to lower values as the temperature is increased. Up to our knowledge, this is the first experimental evidence



of this kind of behavior. The surface-sensitive ARPES measurement didn't observe any change in the position of the Fermi level as a function of temperature, Fig1. Indicating that the oscillations are coming from the bulk and not the Dirac surface states. Future experiments using ion-liquid gating, which allows tuning the Fermi level, have to be carried on to unambiguously find out the origin of the observed QOs.

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P-17 INFLUENCE OF GRAIN SIZE ON TRANSPORT AND MAGNETIC PROPERTIES OF LA_{0.5}CA_{0.5}MNO₃

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Manganese oxides or manganites are a family of transition metal oxides which are widely investigated due to the colossal magnetoresistance (CMR) – a magnetic field-induced metal-insulator transition close to the Curie temperature. CMR is closely related to the ferromagnetic (FM) metallic phase which strongly competes with the antiferromagnetic (AFM) charge ordered (CO) phase, where conducting electrons localize giving rise to insulator-like behaviour that is not well understood. In this work we focus on polycrystalline (ceramic) La_{1-x}Ca_xMnO₃ samples with different grain size, at the very boundary between CO/AFM insulating and FM metallic phases x = 0.5. Transport and magnetic measurements were performed in order to shed more light on the insulating behaviour in La_{1-x}Ca_xMnO₃ in the CO/AFM phase. We observed drastic changes in dc resistivity and magnetization by varying the level of structural disorder controlled by the grain size. Namely, reduction in the grain size leads to suppression of the CO/AFM phase and growth of the FM phase. The experimental results are discussed within the standard core-shell model, where the core of the grains is CO/AFM and the shell is FM, and recent theories of electron localization.



P-18 FUNCTIONALIZATION OF TIO2 SURFACES WITH COPPER OXIDE NANOGRAINS GROWN BY ATOMIC LAYER DEPOSITION FOR ENHANCED VISIBLE-LIGHT PHOTOCATALYSIS

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Titanium dioxide (TiO2) has been studied intensively as one of the most prominent materials for photocatalytic applications. However, TiO2 has a large band gap of around 3.2 eV that limits absorption in the material to the UV light. In recent years, many studies have been devoted to modifications of TiO2 to increase the photocatalytic efficiency of material in the visible part of sunlight spectrum. In this work, we have studied the impact of nanosized grains of copper oxides, grown by atomic layer deposition (ALD), on photocatalytic activity of thin titanium dioxide (TiO2) films under visible-light irradiation. The size of grains and the crystal phase of copper oxide were controlled by the number of ALD deposition cycles. The x-ray diffraction and x-ray photoelectron measurements revealed preferential formation of CuO for a small number of deposition cycles, while Cu2O forms preferentially for a larger number of cycles. The photocatalytic efficiency of pristine TiO2 under visible light has been enhanced for copper oxide/TiO2 structures in which the nanosized copper oxide grains do not cover the entire TiO2 surface. At the same time, the large increase of the current measured across the copper oxide/TiO2 structures is consistent with the charge transfer from copper oxide grains to TiO2, essential for the observed increase of photocatalytic activity.

P-19 ICCD IMAGING VS LASER INDUCED BREAKDOWN SPECTROSCOPY IN HELIUM ATMOSPHERIC PRESSURE PLASMA JET

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Here a comparison is shown between fast iCCD imaging and newly developed diagnostic method utilizing laser induced breakdown in a helium atmospheric pressure plasma jet. The plasma jet was powered by an 80 kHz high-voltage sine wave and propagated into the ambient air. Nd:YAG pulsed laser (4 ns pulse duration and 5 Hz repetition rate @1064 nm) was focused by a lens into the plasma jet at energy below breakdown threshold in helium. Laser and the plasma source were synchronized with the possibility to change the time delay between them. Depending on the time when the laser arrives, there is a different electron density in the laser focus at the laser pulse arrival. This affects the electron multiplication (avalanche) and the optical emission intensity of the laser induced plasma. We compared the radial profiles of the plasma jet obtained with these two methods. For the laser induced breakdown it was ±0.5 mm and for ICCD measurement it was ±1.75 mm, while



the ionization wave velocities obtained with these two methods were 15 km s-1 and 20 km s-1 respectively. Electrical characteristics of the plasma jet were also presented and one can see a large hysteresis effect when the applied power to the plasma jet was reducing. We show that the laser induced breakdown spectroscopy can be used as a complementary diagnostics technique with ICCD measurements.

P-20 SYNTHESIS OF SILVER, GOLD, AND PLATINUM DOPED ZINC OXIDE NANOPARTICLES BY PULSED LASER ABLATION

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In nanotechnology, nanoparticles have a crucial role due to their exceptional magnetic, electrical, mechanical, optical, and electronic properties with respect to the bulk materials. Zinc oxide (ZnO) is one of the most prominent and widely used n-type semiconductors with unique physicochemical properties. Implementing a new element in the crystal structure of ZnO leads to enrichment of the electrical and optical properties and broadens the area of its application. Pulsed laser ablation in liquid (PLAL) is a simple and effective method yielding high purity nanoparticles with a fast production rate [1,2]. In this work, a newly developed synthesis method for silver (Ag), gold (Au), and platinum (Pt) doped ZnO nanoparticles is presented. The method is based on the combination of pulsed laser deposition (PLD) and PLAL techniques. With PLD, metal (Ag, Au, Pt) thin layers were deposited on ZnO substrates. Such formed two-layer structures were used as a target for the doped nanoparticles (ZnO: Ag, ZnO: Au, and ZnO: Pt) production by pulsed laser ablation in water. The optical properties, crystalline structure, elemental composition, morphology, and nanoparticle size distribution were studied using UV-VIS spectrophotometer, X-ray diffraction (XRD), X-ray spectroscopy (XPS), and scanning electron microscope (SEM), respectively.

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P-21 BIOLOGICAL NANOSTRUCTURES IN COMBINATION WITH HOLOGRAPHY FOR THERMAL IMAGING CAMERA

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Using Biological nanostructures and holography we are trying to demonstrate of a novel multispectral imaging camera. We use insect (butterfly) wings as a biological nanostructure for sensing with possibility to use artificial structure in a future.



These butterfly wings in combination with thermophoretic effect can be used for optical reading. Structures in wings absorb some portion of light, which results in slightly higher temperature of the surrounding gas on the irradiated side (compare with opposite side). This temperature difference creates a mechanical pressure acting on one side. Very small pressure creates very small mechanical deflection, but at the end it can be detected with sensitive holographic technique.

Experimental setup is configured as a Twyman – Green interferometer for holographic microscope, and He-Ne laser as a light source. We use additional laser to heat just a part of the wing. Afterwards, thermal response can be reconstructed from the recorded hologram. In collaboration with ORQA, company from Osijek, we are in procedure of development a standalone device for real time reconstruction. This device is equipped with state of the art *nVidia* graphic processor for fast image reconstruction. We aim to achieve real time thermal imaging camera as a standalone device with artificial sensing component.

P-22 AFFECTIVE MYCOTOXIN DEACTIVATION FROM CONTAMINATED CEREALS USING LOW-PRESSURE GASEOUS PLASMA

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Mycotoxins are secondary metabolites of fungi, which can affect various crops and foodstuffs, including cereals, nuts, spices, dried fruits, peanuts, coffee beans and so on. The contamination of products with mycotoxins can occur already in the field, during harvest or after it [1]. However, infection of the crop with fungi (mould) does not necessarily indicate the presence of mycotoxins and vice versa (fungi may already die, but mycotoxins remain), as fungi produce mycotoxins only under warm, damp and humid conditions.

Hundreds of different mycotoxins are identified, but the most toxic and dangerous to human health and livestock are aflatoxins, ochratoxin A, patulin, fumonisins, zearalenone and nivalenol/deoxynivalenol. These mycotoxins are produced by different species of fungi with which the crops are infected. Fusarium species of fungi infect crops in the field. Under suitable conditions, fungi form the mycotoxins fumonisins, zearalenone and trichothecenes (deoxynivalenol, nivalenol, T-2 toxin). Species of fungi Penicillium and Aspergillus infect feed and crops during the storage and can produce storage mycotoxins (ochratoxin A, aflatoxins B1, B2, G1, G2, etc.) [2]. Humans and animals are exposed to mycotoxins by eating contaminated food and feed, which may cause acute poisoning, immune deficiency and cancer.

A very effective method for mycotoxin deactivation is a low-pressure oxygen plasma sustained in a ICP RF reactor. Depending on discharge powers, mycotoxin deactivation takes from a few seconds up to 100 s for complete inactivation (Figure 1).







[1] https://www.who.int/news-room/fact-sheets/detail/mycotoxins

[2] https://www.kis.si/Mikotoksini/

P-23 IMPROVED SURFACE CHARACTERISTICS OF MEDICAL IMPLANTS BY LOW-PRESSURE PLASMA TREATMENT

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Low-pressure non-equilibrium gaseous plasma is one of the most effective tools for the tuning of materials' surface characteristics. It is widely used and has technologically matured in many fields, but has only recently experienced its break through in the field of medicine. The increase in population and longer life expectancy are causing a major burden to the medical systems across the globe and plasma technologies are believed to be the sustainable solution. While atmospheric-pressure plasma can be used for both direct (in contact with living tissue) and indirect treatment (in contact with materials later exposed to living tissues), the low-pressure plasma can only be applied for indirect treatment. Medical implants are predominantly made out of metals and metal alloys such as stainless steel, magnesium, cobalt-chromium, titanium, nickel-titanium, etc. Each one has a set of unique surface characteristics with pros and cons when it comes to medical applications. Their common point is all of them can and should be improved with the aim of minimising surgical and postsurgical complications (predominantly bacterial infections) and for improved biocompatibility, enabling body to accept the implant faster and in a more efficient manner.

In the present study, a low-pressure radio frequency (RF) inductively coupled plasma (ICP) was used for tailoring characteristics of Ti6Al4V model surfaces. Long glass tube was used as the plasma reactor and vacuum pump evacuated it down to the pressure of 1 Pa. Oxygen and hydrogen were used as feed gases for igniting plasma under different conditions. E-mode and H-mode plasma was ignited depending on plasma power set on the generator. The effects of each treatment were studied in depth by XPS, SEM, AFM, WCA and bacterial tests. The results show fundamental differences in surface



characteristics between E-mode and H-mode plasma treated Ti6Al4V and improved bacteriostatic properties against *Escherichia coli*.

P-24 LATERAL INHOMOGENEITIES IN W/C MULTILAYER MIRRORS

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To obtain considerable reflectivity of hard X-rays by tungsten/carbon (W/C) multilayers for angles of grazing incidence >2° requires a bilayer period of less than 2.5 nm and a high quality of the multilayer structure. In this work, a series of W/C multilayered stacks, with different C and W layer thickness and different power applied on the W target, have been prepared by sequential RF/DC magnetron sputtering. Information on the lateral W-layer homogeneity has been retrieved from grazing incidence small angle X-ray scattering (GISAXS) measurements. X-ray reflectivity (XRR) measurements have supplied additional information on the multilayer quality. W-layers thinner than 0.9 nm comprise isolated islands, while beyond a thickness of 1.4 nm homogeneous and continuous W-layers were formed. The evolution of the inter-island separation with the thickness of the W-layers follows a power law with an exponent of \sim 0.37+/-0.04. The growth of C-layers tends to smooth out the relatively high roughness of the island-like morphology of the preceding W-layers.

P-25 3D NETWORKS OF GE QUANTUM WIRES IN AL₂O₃, SIC AND SI₃N₄ MATRICES

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We explore 3D networks of Ge quantum wires formed in different dielectric matrices: Al_2O_3 , SiC and Si₃N₄. The dependences of the geometrical properties of the quantum wire networks on the matrix type and annealing treatment are investigated, as well as the optical and photo-electrical properties of the materials. We show that matrix type influences the geometry of the quantum wire network, but the regular ordering can be achieved in all mentioned matrices. The optical properties are slightly affected by the matrix type; however, the matrix strongly affect the photo-electrical properties of the materials. Strong photo-response is obtained for the Ge quantum wires in the Si₃N₄ matrix, but some samples with SiC matrix have similar behaviour. Also, the multi-exciton generation is observed in the most of the investigated samples.



P-26 ENHANCED QUATUM EFFICIENCY BY MULTIPLE EXCITON GENERATION

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Thin films were prepared using magnetron sputtering co-deposition of Ge and alumina. These thin films consist of 3D-ordered network of Ge quantum wires in an alumina matrix. The shape and arrangement properties of the formed quantum structures was determined from the GISAXS (Grazing Incidence Small Angle X-ray Scatting) measurements. Spectral response (SR) measurements are used in order to estimate the efficiency of incident photon-electron conversion efficiency (IPCE). The enhanced photocurrent is the consequence of multiple exciton generation in the films prepared with the presence of nitrogen. We believe that our thin films could enhance the efficiency of light conversion in silicon multi-junction solar cells.

P-27 IMPROVEMENT OF SURFACE WETTABILITY OF PVC URINARY CATHETERS

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Urinary catheters are often made of polyvinyl chloride. Their surface needs to be modified to prevent bacterial infections. One possibility is to coat them with a layer of an antibacterial agent. However, their surface is very hydrophobic with a water contact angle of approximately 95° which prevents good adhesion of a coating with the surface. To overcome this problem, we exposed catheters to RF inductively coupled plasma to activate their surface. Treatment in oxygen plasma caused only minor approval of surface wettability from 95° to approximately 73°. Therefore, additional pre-treatment of a polymer was introduced using VUV radiation from hydrogen plasma. Such a two-step treatment using hydrogen plasma to make dangling bonds on the surface, followed by oxygen plasma to incorporate polar oxygen functional groups cause pronounced improvement of the surface wettability. By varying plasma exposure time we optimized treatment procedure and found the water contact angles as low as 34°.



P-28 FUNCTIONAL MODIFICATION OF MEDICAL TEXTILES USING LOW-PRESSURE GASEOUS PLASMA TREATMENT

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Medical textiles are typically non-woven, spun-blow polymers, with good mechanistic properties, and excellent hydrophobic quality, which is meant to deflect droplets of biological fluids and thus protect personnel. Polymers like polypropylene and polyethylene terephthalate are relatively cheap and display high hydrophobicity due to their low surface free energy. This property makes them great materials for medical textiles, but difficult to modify with polar solvents to impart functional properties to them. Gaseous plasma is a complex mixture of electrons, ions, atoms and molecules in ground or excited states. Depending on the type of gas used, gaseous plasmas can change the molecular structure of surfaces, improving their wettability. Since they can be operated at near room temperature, they are suitable for modifying sensitive materials, such as medical textiles. Using a gaseous discharge, we've successfully modified a polypropylene material to be sufficiently hydrophilic and serve as an activated surface for imparting functional properties to. The chosen functional property was antimicrobial activity, which was achieved by applying a polar solution containing an antimicrobial ingredient. The prepared material was able to reduce the number of microbes present by over 7 log₁₀ units in 2 hours, verified by a plaque assay. The non-treated material itself provided no antimicrobial functionality, and was unable to absorb the polar solution, while the activated surface showed no antimicrobial activity, demonstrating that the entire treatment process alone is needed to achieve antimicrobial attributes. This approach may lead to creating functional materials, which can be applied in many industries and areas where unwanted microbes can cause harm, for example medical, food, agriculture or water treatment sectors.

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P-29 GisaxStudio - A PLATFORM FOR GISAXS ANALYSIS OF NANOSTRUCTURED MATERIALS

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We present a software platform for efficient structural analysis of nanostructured materials by grazing incidence small angle X-ray scattering (GISAXS). The platform includes several models describing different ordering properties of nanostructures, enabling its usage for a wide class of materials. It allows reading and exporting the measured GISAXS maps, taking line profiles from the measurements, simulation of the measured data using different models and structural parameters as well as fitting of the model parameters to the measured values. The output parameters include the shape and size of the nanostructures, their ordering type, unit cell parameters and their statistical distributions. The software is freely available at the webpage: http://homer.zpr.fer.hr/gisaxstudio/



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Upper left: Hard coatings of various tools (*Miran Mozetič*), *Upper right*: AFM images of thin films of blue bronze (K_{0.3}MoO₃) grown by pulsed laser deposition on SrTiO₃ (510) substrate (*Damir Dominko*), *Lower left*: Atomicaly resolved STM image of strained graphene showing sublattice polarisation characteristic of pseudo magnetic field creation (*Iva Šrut Rakić*), *Middle right*: Interaction of atmospheric helium plasma jet when immersed in water (*Slobodan Milošević*), *Lower right*: The surface-sensitive ARPES measurement of BiSbTe₂S doped with Sn (*Mario Novak*).

PROGRAM & ABSTRACTS





1. ANALITSKA OPREMA

www.oxford-instruments.com/products/microanalysis www.jeol.com

- presevni elektronski mikroskopi (**TEM, FEGTEM**)
- vrstični elektronski mikroskopi (SEM, FEGSEM)
- Auger spektrometri in XPS spektrometri (ESCA)
- masni spektrometri (MS MALDI TOF, GC TOF, EBSD analiza z elektronsko difrakcijo QMS)
- NMR spektrometri , ESR spektrometri
- EDS –energijsko disperzivni spektrometri
- WDS valovno dolžinski spektrometri

 - EBL elektronska litografija

2. PRIPRAVA VZORCEV

<u>www.jeol.com</u>

www.gatan.com

www.rmcproducts.com

www.quorumtech.com

www.2spi.com

- vakuumski naparjevalniki
- instrumenti za brušenje in poliranje, jedkanje
- vakuumska impregnacija
- FIB instrumenti za ionsko jedkanje
- IS ionsko tanjšanje za TEM
- Mehanska priprava za TEM vzorce

- diamantne žage (na disk, na diamantno nit)
- vakuumski napraševalniki
- mikrotomi in ultramikrotomi
- CP ionsko jedkanje površin brez defektov na površini in mejah zrn za FEGSEM

3. KRIOTEHNIKA

www.cryopal.com

- tekočih plinov (tekoči dušik, helij, ...)
- kontejnerji za shranjevanje bioloških vzorcev v tekočem dušiku
- kontejnerji za prenos, pretakanje, skladiščenje
 kontejnerji za suh transport zmrznjenih vzorcev na temperaturi tekočega dušika
 - instrumenti za programirano zamrzovanje do 196°
 - zaščitna oprema za kriotehniko



4. VAKUUMSKA TEHNIKA

<u>www.pfeiffer-vacuum.com</u>

www.vatvalves.com

www.hsr.li

- vse vrste vakuumskih črpalk (rotacijske, suhe, roots, membranske, difuzijske, turbo-molekularne, krio, ...)
- vakuumski merilniki
- kvadrupolni masni spektrometri (**QMS**)

- vakuumski sistemi po naročilu
- He detektorji netesnosti
- vakuumski ventili, komore, komponente, olja, masti, ...

5. LABORATORIJSKI INSTRUMENTI

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- zamrzovalne omare horizontalne, vertikalne, različnih velikosti do **-90 °C**
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- termostatirane vodne kopeli

- brezprašne komore
- vakuumski koncentratorji
- samostoječe zamrzovalne centrifuge
- namizne centrifuge

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Tvrtka Kobis od 1990. godine posluje u Sloveniji, a otvaranjem još jedne tvrtke u Zagrebu 2010. širi svoje poslovanje i na područje Hrvatske . Imena kao što su Thermo Scientific - Material Science Division, Kurt J. Lesker, TSI i Digitel naši su glavni partneri s kojima uspješno surađujemo te svojim korisnicima osiguravamo kvalitetne proizvode i usluge. U našem asortimanu možete pronaći spektrometre za analizu materijala, vakuumske komponente i uređaje za naparivanje, instrumente za prikupljanje i analizu aerosola i zraka, te laboratorijske i industrijske ekstrudere i reometre.

Više informacija možete saznati našoj web-stranici: <u>www.kobis.hr</u> ili nam se slobodno obratite na <u>info@kobis.hr</u> a mi ćemo vrlo rado odgovoriti na sve Vaše upite.

Veselimo se budućim poslovnim suradnjama i daljnjem rastu i razvoju kroz zajedničke projekte!