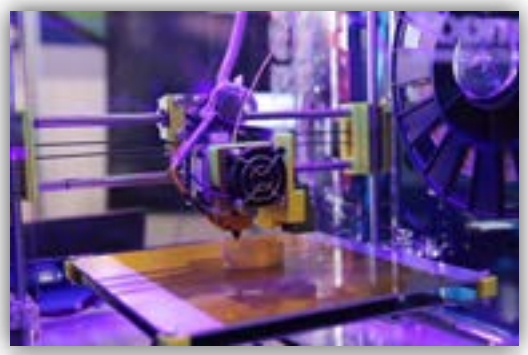
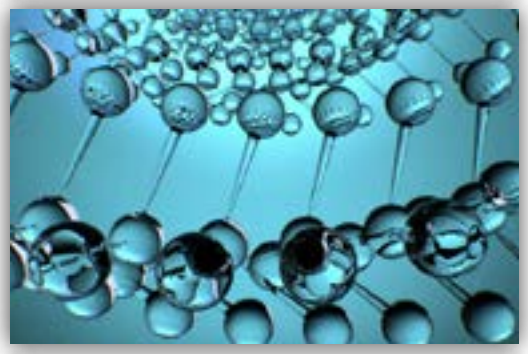
13th Annual Conference on

Materials Science, Metal and Manufacturing

November 16-17, 2017 Paris, France

Scientific Tracks & Abstracts

Day 1



Major Sessions:

Surface Coatings Technology and Thin Films | Biomaterials, Biodegradables and Biomimetics | Energy Materials, Devices & Superconductors | Graphene, Fullerene, Semiconducting and 2D materials

Session Chair
Se-Young Jeong
Pusan National University, Republic of Korea

Session Chair
Masaru Miyayama
The University of Tokyo, Japan

Session Introduction

Title: **Fabrication of wafer-scale grain boundary free Cu single crystal film and Copper oxide film by sputtering method and its application**
Se-Young Jeong, Pusan National University, Republic of Korea

Title: **Flexible all-solid electrochemical capacitors composed of inorganic nanosheets**
Masaru Miyayama, The University of Tokyo, Japan

Title: **Interface-driven formation of a two-dimensional dodecagonal fullerene quasicrystal**
Silvia Karthäuser, Forschungszentrum Jülich GmbH, Germany

Title: **Build-up of new nature-mimicking materials using automated simulation routines—the future trend?**
Mikko Kanerva, Tampere University of Technology, Finland

Title: **Extreme and unusual mechanical properties of graphene**
J. H. Los, A. Fasolino, Radboud University, The Netherlands

Title: **Surface change in ion-plasma flows**
Evgeny Moos, Ryazan State University, Russia

Title: **Lean manufacturing techniques optimization in redesigning test-bench chain to withstand high torque during operation**
Abimbola O Aniki, Vaal University of Technology, South Africa

Title: **Independently tunable dual-band coherent perfect absorption based on metal-graphene metasurface**
Jiangnan Si, Shanghai Jiao Tong University, China

Se-Young Jeong, Mater Sci Nanotechnol 2017, 1:2

Fabrication of wafer-scale grain boundary free Cu single crystal film and copper oxide film by sputtering method and its application

Se-Young Jeong
Pusan National University, Republic of Korea

Copper thin films have been widely used as electrodes and interconnection wires in integrated electronic circuits, and more recently as substrates for the synthesis of graphene. However, the ultra-high vacuum processes required for high-quality Cu film fabrication, such as molecular beam epitaxy (MBE), restricts mass production with low cost. In this work, we demonstrated high-quality Cu thin films using a single-crystal Cu target and sputtering technique; the resulting film quality was comparable to that produced using MBE, even under unfavorable conditions for pure Cu film growth. The Cu thin film was epitaxially grown on an Al_2O_3 (0001) substrate, and had high crystalline orientation along the (111) direction. Despite the 10^{-3} Pa vacuum conditions, the resulting thin film was oxygen free due to the high chemical stability of the sputtered specimen from a single-crystal target; moreover, the deposited film had > 5 X higher adhesion force than that produced using a polycrystalline target. We applied the technique fabricating the single crystal thin film to the flexible transparent conducting electrodes, where a micromesh/nanomesh structure was fabricated on a polyimide substrate using UV lithography and wet etching. We also succeeded to fabricate a wafer-scale graphene in the formation of artificial single crystalline AB-BLG via aligned transfer of two single-crystalline monolayers. Such single crystal copper film was realized not only on the sapphire substrate, but also on the PI, PET, and PC, which enabled to apply in the region of flexible devices, metamaterial and of surface plasmonics. The important advantage of this single crystal copper film is due to the natural oxide layer with a thickness of around 2nm, which protects further oxidation, so that the copper layer maintains clean even for 2-3 years without any capping layer. Well-defined conditions enabled the copper film to convert to Cu_2O or CuO partially or totally, which are transparent and p-type semiconductor. In the partially oxidized case, the copper layer left beneath Cu_2O or CuO could be used as electrode. The color of the film varies between transparent gold and opaque metallic scarlet depending on the ratio of metal and oxides. Thanks to the grain free copper thin film, the copper oxides also maintain high crystallinity.

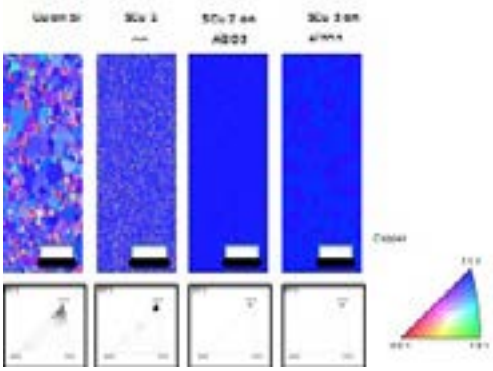


Figure 1: The EBSD images of commercial copper film (Cu on Si), single crystal copper film under unoptimized conditions SCu_1 and SCu_2) and single crystal copper film under optimized condition (SCu_3)

Recent Publications

- Nguyen VL, Perello DJ, Lee S, Nai CT, Shin BG, Kim JG, Park HY, Jeong HY, Zhao J, Vu QA, Lee SH, Loh KP, Jeong SY and Lee YH (2016) Wafer-scale single-crystalline AB-stacked bilayer graphtene. Advanced Materials, 28: 8177-8183.
- Lee S, Wi HS, Jo W, Cho YC, Lee HH, Jeong SY, Kim YI, Lee GW (2016) Multiple pathways of crystal nucleation in an extremely supersaturated aqueous potassium dihydrogen phosphate (KDP) solution droplet, PNAS 113: 13618-13623.
- Kim WK, Lee S, Lee DH, Park IH, Bae JS, Lee TW, Kim JY, Park JH, Cho YC, Cho CR, Jeong SY (2015) Cu Mesh for Flexible Transparent Conductive Electrodes. Sci. Rep. 5: 10715-10722
- Kim JY, Oh MW, Lee S, Cho YC, Yoon JH, Lee GW, Cho CR, Park CH and Jeong SY (2014) Abnormal Drop in Electrical Resistivity after Impurity Doping of Single Crystal Ag. Sci. Rep. 4: 05450-05454
- Phamcong D, Choi JH, Yun J. Bandarenka A. Kim J. Braun P. Jeong SY, Cho CR (2017) Synergistically Enhanced Electrochemical Performance of Hierarchical MoS2/TiNb2O7 Hetero-Nanostructures as Anode Materials for Li-Ion Batteries. ACS Nano 11: 1026-103.

Biography

Se-Young Jeong has his expertise in crystal growth and the investigation of physical properties such as structure, electricity and magnetism. He has been in charge of the crystal bank of a research institute for 20 years, which grow single crystals and supply the samples to the researchers. He has grown more than 100 kinds of single crystals including MgB2, GaN single crystals, and also contributed to develop ZnCoO DMS having room temperature ferromagnetism. Recently, he is studying on metal single crystal thin film. Especially, his recent study attracts lot of attention from the community, because recently developed copper films in his group by the modified sputtering system shows almost perfect crystallinity without grain boundaries even in wafer-scale, which has been required as the substrate for graphene growth and has lots of application possibilities.

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Notes:

Masaru Miyayama, Mater Sci Nanotechnol 2017, 1:2

Flexible all-solid electrochemical capacitors composed of inorganic nanosheets

Masaru Miyayama
University of Tokyo, Japan

Protonic electrochemical capacitors using oxide electrodes and aqueous electrolyte is a promising candidate for the energy storage device with high energy & power densities and reliable safety. The use of solid electrolytes in place of aqueous solutions enables to fabricate thin-film type electrochemical capacitors, and it is expected to apply them for various portable devices. "Nanosheets" are plate-like particles with thickness of only a few nanometers, and are prepared by delamination of layer-structured compounds. We found that thin films prepared by restacking of nanosheets have excellent bending durability. Namely, their conductivities are kept almost unchanged under bending deformation. Electrochemical capacitors were assembled with thin-film electrodes of RuO_2 and/or $Hx(Ni,Co,Mn)O_2$ and an electrolyte layer of LDH (layered Mg-Al double hydroxide). These capacitors showed reversible capacities even under bending with a curvature radius of 3 mm. Such flexible electrochemical capacitors are expected to be applied as thin-film energy storage devices for wearable and miniaturized electronic devices. In the talk, mechanisms of the bending durability and effects of electrode configuration are also described.

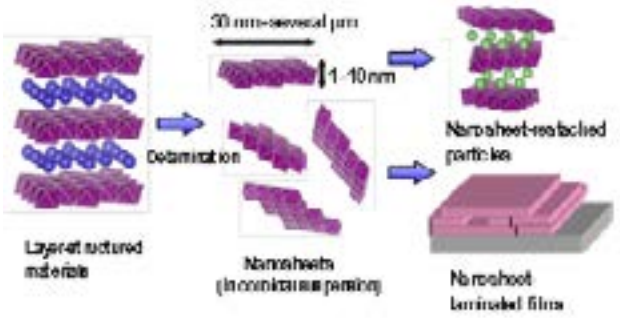

Figure: Nanosheet process: delamination and restacking to particles and thin films.

Recent Publications

- M Yano, S Suzuki, M Miyayama and M Ohgaki (2013) Effects of microstructure on electrode properties of nanosheet-derived $Hx(Ni1/3Co1/3Mn1/3)O_2$ for Electrochemical capacitors. Nanomaterials. 3(2):204-220.
- M Yano, S Suzuki, M Miyayama and M Ohgaki (2013) Electrochemical properties of layer-structured $Hx(Ni1/3Co1/3Mn1/3)O_2$ for electrochemical capacitors in alkaline aqueous solutions. J. Asian Ceram. Soc. 1(1):71-76.
- K Kamei, S Suzuki and M Miyayama (2014) Electrical properties of V_2O_5/carbon composite electrodes in aqueous solutions. J. Mater. Sci. 49(16):5579-5585.
- W Lee, S Suzuki and M Miyayama (2014) Electrode properties of defect-introduced graphene sheets for electrochemical capacitors using aqueous electrolyte. Electrochim. Acta. 142:240-246.
- H Jang, S Suzuki and M Miyayama (2014) The role of Cu ions of the self-reassembled MnO_2 nanosheets for rechargeable aqueous batteries. J. European Ceram. Soc. 34(16):4297-4304.

Biography

Masaru Miyayama is a Professor of Department of Applied Chemistry, School of Engineering, The University of Tokyo. He got his Bachelor's in Engineering in 1977 and Master's in Engineering in 1979 on Inorganic Materials Chemistry, and Doctor's degree in 1987 on Functional Ceramic Materials, all from The University of Tokyo. He started to work as a Research Associate in 1979, and was promoted to a Full Professor of The University of Tokyo in 2001. His research interests include ferroelectric, conducting and electrochemical properties of oxide-based materials, and materials design through nanostructure control and defect engineering. He is a Fellow of The Ceramic Society of Japan.

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Silvia Karthäuser, Mater Sci Nanotechnol 2017, 1:2

Interface-driven formation of a two-dimensional dodecagonal fullerene quasi crystal

Silvia Karthäuser
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Close-packed monolayers of Buckminsterfullerenes (C_{60}) on metallic substrates are very rich systems with respect to their rotational degrees of freedom and possible interactions with different adsorption sites or next neighbors. They have attracted much attention due to their structural and electronic properties. Here, we focus on the ability of C_{60} to form self-assembled monolayers that mirror impressively the electronic properties of the respective substrate. Using low-temperature UHV-STM and STS in combination with DFT calculations the interactions of C_{60} molecules with a metallic surface, an alloy, and a thin titanium oxide film are characterized in detail. The LT-STM images with highly resolved orbital structure allow a detailed assignment of the C_{60} adsorption orientation and geometry with respect to the underlying substrate. Moreover, even second order interface effects, that is, interactions of C_{60} with atoms of the subsurface layer are identified. Most interestingly, in the case of a Pt_3Ti-single crystal alloy used as substrate the influence of subsurface Ti-atoms on the self-assembly behavior of fullerenes is determined. By employing DFT calculations, the preferred adsorption sites of the fullerenes have been identified. Here, third layer Ti-atoms provoke an adsorption energy landscape of the Pt_3Ti-single crystal alloy so that the C_{60}/alloy interfacial interactions result in the formation of a two-dimensional dodecagonal fullerene quasicrystal, which can be described in terms of a square-triangle tiling.

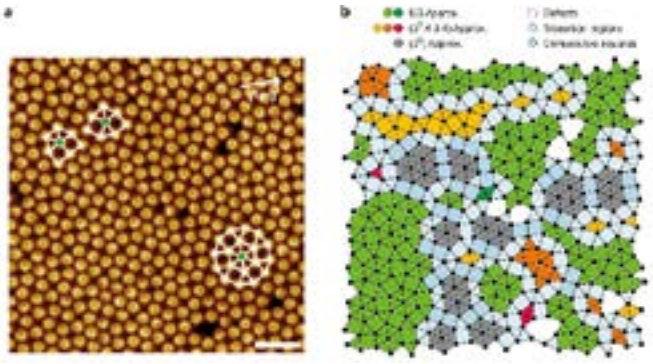

Figure 1: Dodecagonal square-triangle tiling, as measured by STM. (a) High-resolution UHV-STM image of C_{60} on 2Pt-Pt_3Ti(111) (scale bar: 3 nm). One dodecagon and two local structures are indicated in white. (b) Square-triangle tiling extracted from a), with color-coded decomposition into different types of approximants.

Recent Publications

- Paßens M, Waser R, Karthäuser S (2015) Enhanced fullerene-Au(111) coupling in (2√3 x2√3)R30°-superstructures with cooperative intermolecular interactions. Beilstein J. Nanotechnol. 6: 1421-1431.
- Paßens M, Karthäuser S (2015) Interfacial and intermolecular interactions determining the rotational orientation of C_{60} adsorbed on Au(111). Surf. Sci. 642: 11-15.
- Paßens M, Caciuc V, Atodiresei N, Moors M, Blügel S, Waser R, Karthäuser S (2016) Tuning the surface electronic structure of a Pt_3Ti(111) electro catalyst. Nanoscale 8: 13924-13933.
- Paßens M, Moors M, Waser R, Karthäuser S (2017) Energy level alignment at the fullerene/titanium oxide ultrathin film interface. J. Phys. Chem. C 121: 2815-2821.
- Paßens M, Caciuc V, Atodiresei N, Feuerbacher M, Moors M, Dunin-Borkowski R E, Blügel S, Waser R, Karthäuser S (2017) Interface-driven formation of a two-dimensional dodecagonal fullerene quasicrystal. Nat. Commun. 8: 15367.

Biography

Silvia Karthäuser has her expertise in the self-assembly of organic molecules and nanomaterials on surfaces; surface analysis and electronic transport phenomena with spectroscopic and scanning-probe methods; design, fabrication and electronic characterization of novel nano-electronic test devices. Special interest: phenomena at organic-metal or organic-semiconductor interfaces; chemical structure – electronic property relationship of functional organic molecules; addressing molecular structures by external triggers, e. g. electronic or photonic.

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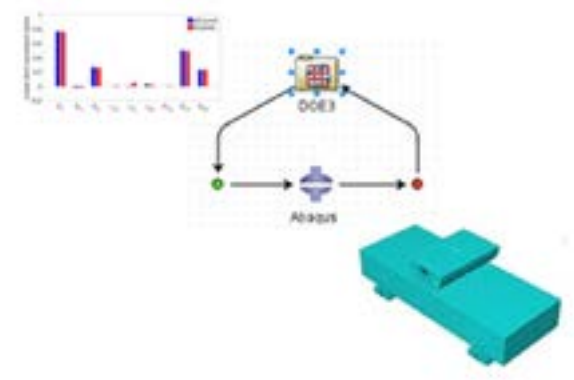
Mikko Kanerva at al., Mater Sci Nanotechnol 2017, 1:2

Build-up of new nature-mimicking materials using automated simulation routines—the future trend?

Mikko Kanerva, Sanna Siljander and **Jarno Jokinen**
Tampere University of Technology, Finland

The current consumption of fossil fuel resources and respective production of traditional polyolefin plastics has led to huge clustering of plastics in oceans as well as in landfill sites. In its simplicity, sole recycling will never solve the waste problems because plastics will anyway be left unrecycled at a finite rate due to the human nature. Biodegradable, isotropic polymer blends are neither a complete solution for all applications because their performance is far behind that of current high-performance polymers, such as the ones of epoxy, vinylester, aramid, and bismaleimide thermoset families. Basically all the biodegradable polymeric systems for structural applications are continuous fibre-reinforced plastics. In these composites, either the reinforcement (e.g. bio-based fibres) or the polymer matrix is the degradable component. The reinforcing particles can have various forms and involve wood particles and fibres, natural fibres (e.g. flax or hemp), clay, starch, and cellulose. For high performance applications, the outcome of these studies boils down to the fact that there is always a distinctive compromise between a high bio-particle content and good mechanical properties, or, in other words, the composites represent a double-edged sword with some sustainability and mechanical performance. However, a carefully adjusted mixture of synthetic and natural fibres can result in a better mechanical response, e.g. against impact loads, compared to composites with only either type of reinforcement. Graphite as well as carbon nanotubes have excellent electrical, mechanical and thermal properties. For these reasons they are considered to be used in many types of composites in the future. Combining CNTs with cellulose has known to be eco-friendly, efficient, low cost and non-metal based option. Applications of CNT/cellulose composites usage are reported to be in the fields of electromagnetic interference shielding, chemical vapour sensors and in pressure sensing. Also, totally new species of advanced 'nat- ural' materials are being developed. For example, the nacre-mimetic materials are a type of nano-composite that significantly benefits the synergetic arrangement of its rather unique poly(vinyl alcohol)/clay building blocks. The maturity of these materials is on a laboratory level and will take long until their processing can reach commercial needs. Eventually, any environment degrades the material properties of polymeric systems. In order to create new high-performance composites, the degradation behavior must be understood and controlled. Especially the fibrous composite materials are challenging to analyse considering the aging response. Even pure linear anisotropic models will require nine engineering constants per material not to mention the interface models to tie different layers together, or the internal residual stress models.The question from the numerical analysis point of view is how to define relevant parameters when modelling the environmental effects of laminate or an entire structure. This presentation will deal with the application of automated simulation routines to design new materials. Ex- amples of using Abaqus-Isight (Simulia) coupling are presented for understanding the aging in high-performance glass-fibre reinforced composites (Fig. 1(a)). The focus in these cases are on the challenges of building up the material model for a layered composite with correct interface models. In the second part of the presentation, examples of new materials with optimized nano-strengthening are presented (Fig. 1(b)). Film preparation using nanofibrillated cellulose, CNTs as well as electrospinning are described with emphasis on the sonication models, particle-ratios and de-hydration. The presentation will discuss the future trends in using autonomous and smart numerical simulations to screen most potential multi-composites for optimized behavior in specific applications.



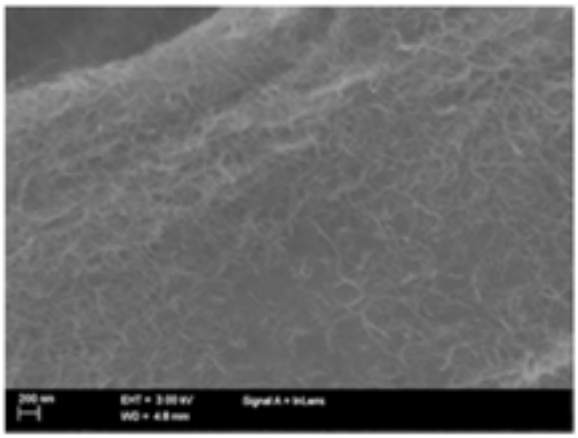


Figure 1: a) Stacked simulation routine description when using finite element methods (Abaqus/Isight) for understanding aging-effects on the flexural behavior of fibrous composite laminates. b) SEM imaging of an optimized material based on MWCNT network on a NFC surface.

Biography

Professor (tenure track) Mikko Kanerva leads the research group of Plastics and Elastomer Technology in Tampere University of Technology, Laboratory of Materials Science. His group of 17 researchers focuses on the synthesis and modelling of polymer composite materials through the application fields of aerospace and the infrastructure. He has been teaching programmes such as Aircraft Structural Design, Composites, and Airline Transport Pilot training, for instance. Kanerva has completed his PhD from Aalto University. He serves as the representative of Finland for the International Council of the Aeronautical Sciences (ICAS) and its Programme Committee, Early Career Committee, and External Relations Committee.

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Notes:

J H Los et al., Mater Sci Nanotechnol 2017, 1:2

Extreme and unusual mechanical properties of graphene

J H Los, A Fasolino and **M I Katsnelson**
Radboud University, Netherlands

Graphene and other 2D materials continue to surprise scientists because of their unusual, special properties. Not in the last place these also include their thermodynamic and mechanical properties. Graphene is extremely stable and strong, in contrast to the earlier belief expressed by the Mermin-Wagner theorem that a 2D crystal would be unstable against long wavelength fluctuations and crumple. Using an approach based on nucleation theory and simulation, we have been able to establish that graphene's melting temperature is even higher (by a few hundred degrees) than that of graphite. Concerning its mechanical properties, it turns out that the elastic moduli of graphene are not material constants but, at finite temperature, depend on the system size as a power law, a peculiar behavior completely different from the kind of change in the moduli observed when going from bulk materials to clusters of nanoscale. To give an impression, for a system of 1 cm^2, the in-plane elastic constants are about 100 times (!) smaller while the out-of-plane elastic constant, i.e. the bending rigidity, is about 10000 times (!!) larger than for a system of nanometer size. This special size dependence, predicted earlier in the theory of membranes and confirmed by simulations and experiments has important implications for nano-indentation of a graphene drum, used in experiments to determine the Young modulus. Consequently, the Schwerin equation, routinely used to derive the Young modulus from such experiments, must be essentially modified for graphene at room temperature and for micron sized samples, as we have shown recently.

Recent Publications

- N D Mermin (1968) Crystalline order in two dimensions. Phys. Rev. 176(1):250-254.
- J H Los, K V Zakharchenko, M I Katsnelson and Annalisa Fasolino (2015) Melting temperature of graphene. Phys. Rev. B. 91:045415.
- David Robert Nelson (2004) Statistical Mechanics of Membranes and Surfaces. World Scientific. Volume. Page Numbers.
- M. I. Katsnelson (2012) Graphene: Carbon in two dimensions. New York Cambridge University Press. ISBN: 9780521195409.
- J H Los, M I Katsnelson, V Yazyev, K V Zakharchenko and A Fasolino (2009) Scaling properties of flexible membranes from atomistic simulations: Application to graphene. Phys. Rev. B 80(12):121405(R).

Biography

Jan H Los completed PhD in the theory of condensed matter group at the Radboud University in Nijmegen (Netherlands). He has worked as a Researcher in different locations in Europe on various topics in the field of theory of condensed matter, modelling and simulation. His current research activities concentrate on graphene/2D systems, their (statistical-)mechanical properties, development of effective interatomic interaction models enabling large scale simulation.

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E N Moos et al., Mater Sci Nanotechnol 2017, 1:2

Surface change in ion-plasma flows

E N Moos, S V Gavrilov, M N Makhmudov, A I Kudyukin and **V A Stepanov**
Ryazan State University, Russia

The interaction of electrodes with ion-plasma flows changes the state of their surface, including blistering in devices of plasma electronics. In addition, the state of cathodes based on aluminum oxides (Al-Mg), the change in the electrodes of magnetically controlled contacts (Fe-Ni), the electrodes of vacuum arc interrupters (Cu-Cr) is changing. Processes and mechanisms of interaction of plasma flows with a surface are still relevant. The report studies the evolution of the surface of electrodes in ion-plasma flows and simulates changes in the morphology of electrodes in an arc discharge under controlled gas and vacuum conditions. In the work, the processes were studied by a complex of methods of X-ray photoelectron spectroscopy, electron microprobe analysis, layer-by-layer and raster mode, and atomic force microscopy. A layer analysis, for example, of an aluminum cathode oxide of He-Ne laser containing dopants of magnesium and iron, reveals segregation of carbon to the surface and simultaneously a change in the concentration of free aluminum, magnesium, and oxygen. Blistering, known for spacecraft and nuclear installations with ion beam energies of tens and hundreds of keV, was detected in electrodes of gas-filled devices containing neon atoms of the order of 2, 11 wt.%. In the vacuum arc discharge of the surface of Cu-Cr electrodes, the concentration of Cu atoms (the main substance of the alloy) and the oxygen on the surface are higher than the bulk values. The copper content is reduced in volume to 78.2%. In the cathode region, the auto electrons initiating the arc discharge, generated in the emission centers by high current densities that stimulate the heating of this zone and are accompanied by the spraying of the substance of the electrodes. In the melting zone, the oxygen concentration decreased more than twofold from 4.9 wt.% up to 2.2 wt.%.

Biography

Evgeny Moos is a Professor since (1997-2017) at Department of General Physics, Ryazan State University, Ryazan, Russia. Lectures on natural history and general physics: mechanics, molecular physics and thermodynamics, electricity, optics and Physics laboratory: mechanics, molecular physics and thermodynamics, electricity, optics, atomic physics and quantum electronics.

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Notes:

Abimbola O Aniki, Mater Sci Nanotechnol 2017, 1:2

Lean manufacturing techniques optimization in redesigning test-bench chain to withstand high torque during operation

Abimbola O Aniki
Vaal University of Technology, South Africa

The crawler chains of underground continuous miners transfer the torque induced by traction reducers to the ground. The translation of circular motion to lateral motion enables the Continuous Miner to move forward or backwards. However, the crawler chain is unfortunately too bulky for use at the test bench for testing purposes as there is a human interface in assembling and disassembling of the chain. Therefore, research had to be done to investigate other alternative materials that could be used to mould the crawler chain. The material must be light in weight and be able to handle the large torque values or alternatively re-design the chain to a lighter one. The aim is to reduce 50% of the weight of a single link. Investigation and exhaustive research will be conducted in fabricating the new designs of the chain as well as considering the cost effectiveness of the manufacture of the chain to be used. The analysis is to check if the new designed test bench chain can handle the high torques generated during operation.

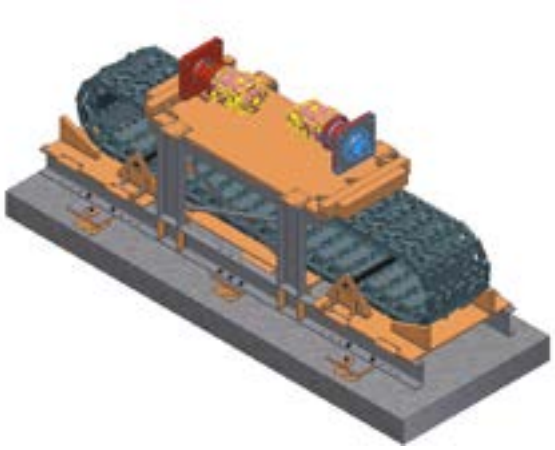

Figure 1: Shows the test bench chain configuration system

Figure 2: Describe the traction reducer test bench fully assembled

Recent Publications

- Bolarinwa G O, Aniki A O, Farounbi J A, Aduloju S C (2015) The effects of iron-ore tailings on setting times of some commercial cement. Scholars Journal of Engineering and Technology. 3(1A):14-20.
- Bolarinwa G O, Aniki A O, Aduloju S C (2015) Investigation of compressive strength of concrete from cement and iron-ore tailings mixture. Scholars Journal of Engineering and Technology. 3(5A):560-562.

Biography

Abimbola O Aniki graduated in 2002 from University of Ilorin, Nigeria (Mechanical Engineering, Production/Maintenance option) worked with Lafarge Cement Nigeria as Inspection Engineer, Methods Department. He had his Master's Degree at University of Johannesburg, South Africa from Department of Mechanical Engineering. He is currently lecturing at Vaal University of Technology. South Africa. He has several conferences and journals focusing on Maintenance field and has contributed greatly on the big project at Lafarge Cement which titled K1MR- Kiln 1 Major Repair. In his present job, apart from been a Lecturer, is also an examiner, moderator and a visitor WIL student (Work Integrated Learning) at various companies. He is a Researcher and is pursuing PhD Degree.

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Jiangnan Si et al., Mater Sci Nanotechnol 2017, 1:2

Independently tunable dual-band coherent perfect absorption based on metal-graphene metasurface

Jiangnan Si, Xiaoxu Deng and **Xianyi YU**
Shanghai Jiao Tong University, China

A dual-band polarization-independent device based on metal-graphene nanostructures is proposed to realize coherent perfect absorption(CPA) at mid-infrared frequencies, which is composed of golden nanorings with two different sizes placed on graphene finger set. By controlling the relative phase of two incident countering-propagating beams, the coherent absorption at two resonant frequencies can be tuned from 0% to 98.3% and 0% to 98.4% separately. Besides, the coherent absorption can be tuned by the Fermi energy of corresponding graphene finger set, without changing the geometrical parameter of the nanostructures. The finite-difference time-domain (FDTD) solutions are employed to simulate the characteristics of the hybrid metal-graphene dual-band device. Distinguishing from the conventional graphene CPA devices, multiple CPA resonances in the hybrid metal-graphene CPA device are independently modulated by changing bias voltages applied on graphene finger set, which can be widely used in practical applications such as sensors, filters and switchers.

Image: The designed metamaterials for dual-band light CPA of monolayer graphene is sandwiched between the designed nanostructure and the SiO_2 substrate. The designed metal nanostructure is composed of golden nanorings with two different sizes within a unit cell. The small size of nanoring is in the center of the unit cell and the big size of nanoring is at the four corners of the unit cell.

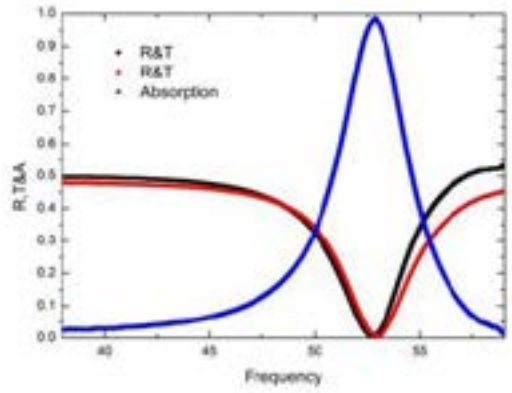

Figure 1: (a) The simulated absorption, reflection and transmission spectra of the small size of golden nanoring on graphene finger set when the Fermi energy EF=0.35eV and the two coherent beams with the same intensities and phases. (b) The simulated absorption, reflection and transmission spectra of the big size of golden nanoring on graphene finger set. (c) The simulated absorption spectra of two sizes of golden nanorings on graphene finger set.

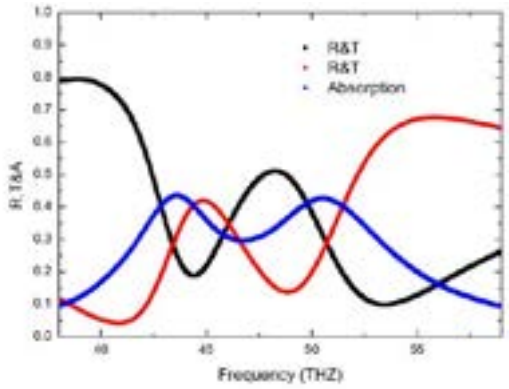

Figure 2: (a) When the phase difference between two countering-propagating coherent beams is 90°, the simulated absorption, reflection and transmission spectra of two sizes of golden nanorings on graphene finger set. (b)When the phase difference between two countering-propagating coherent beams is 180°, the simulated absorption, reflection and transmission spectra of two sizes of golden nanorings on graphene finger set.

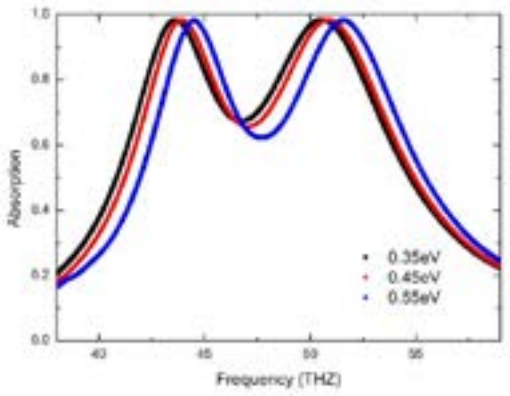

Figure 3: The simulated absorption of the designed metal-graphene nanostructure with different EF=0.35eV, 0.45eV and 0.65eV.

Recent Publications

- Jianfa Zhang, Chucai Guo, Ken Liu, Zhihong Zhu, Weimin

Ye, Xiaodong Yuan and Shiqiao Qin (2014) Coherent perfect absorption and transparency in a nanostructured graphene film. Opt. Express 22(10):12524-12532.

- Hu X, Wang J (2015) High-speed gate-tunable terahertz coherent perfect absorption using a split-ring graphene. Opt. Lett. 40(23):5538-5541.

Biography

Jiangnan Si attended Shanghai Jiaotong University in China from 2011 to 2015 and received Bachelor's degree in Physics. Since 2015 she is pursuing PhD in Optical Engineering at Shanghai Jiaotong University. Her main research interest concentrates on the area of hybrid metamaterials and graphene 2D materials nano structures in PIT (plasmonically induced transparency), EIT (electromagnetically induced transparency) and CPA (coherent perfect absorption), which mainly work in the mid-infrared region.

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13th Annual Conference on

Materials Science, Metal and Manufacturing

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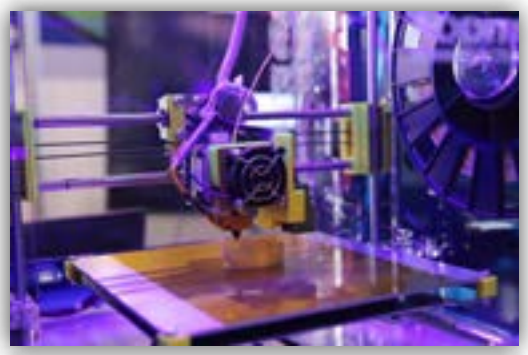
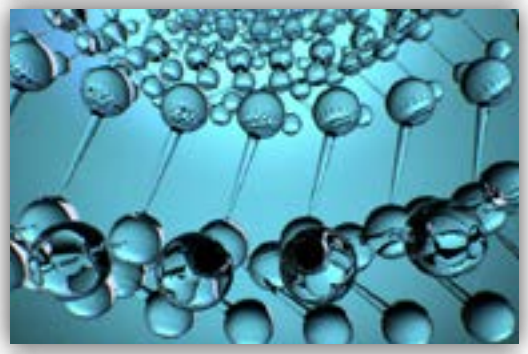
Scientific Tracks & Abstracts

Day 2



Nano-materials & Microstructures | Recycling and Reuse of Materials & Metals

Session Chair
Kaoru Tamada
Kyushu University, Japan

Session Introduction

Title: **High-resolution imaging of a cell-attached nanointerface using a gold-nanoparticle two-dimensional sheet**
Kaoru Tamada, Kyushu University, Japan

Title: **Growth of vertically aligned carbon nanotubes on metallic surfaces**
Cecile Reynaud, Université Paris-Saclay, France

Title: **Thermal plasma extractive metallurgy for e-waste recycling**
Jonathan Cramer, Fondation ParisTech, France

Title: **Corrosion behaviour of 316L stainless steel as biomaterial in physiological environment**
Nicoleta Simionescu, University of Galati, Romania

High-resolution imaging of a cell-attached nanointerface using a gold-nanoparticle two-dimensional sheet

Kaoru Tamada[1], Shihomi Masuda[1], Sou Ryuzaki[1], Pangpang Wang[1], Koichi Okamoto[1], Thasaneeya Kuboki[1], Satoru Kidoaki[1], Yuhki Yanase[2] and **Eiji Usukura[3]**

[1]Kyushu University, Japan
[2]Hiroshima University, Japan
[3]Nagoya University, Japan

This paper reports our original technique for visualizing cell-attached nanointerfaces with extremely high axial resolution (a few tens of nanometers) using collectively excited localized surface plasmon resonance (LSPR) on a self-assembled metal nanoparticle sheet. Oleylamine-capped gold NPs (AuOA, 13nm) and myristate-capped silver nanoparticles (AgMy, 5nm) were self-assembled at an air-water interface and transferred on hydrophobic cover slip by Langmuir-Schaefer method to be an imaging substrate. This self-assembled metal nanoparticle sheet can confine and enhance the fluorescence at the nanointerface. Test experiments on rat basophilic leukemia (RBL-2H3) cells with fluorescence-labeled actin filaments revealed high axial and lateral resolution in the image of focal adhesion at the cell-attached interface even under a regular epifluorescence microscope, which produced higher quality images than those captured under a total internal reflection fluorescence (TIRF) microscope. Recently, the demand for super-resolution fluorescence microscopy is increasing in the field of cell biology because of the requirement to investigate molecular-level dynamic reactions in or near cells. The super-resolution microscopy techniques, such as confocal laser microscopy, STED, SIM, and PALM/STORM, have a significant advantage in their lateral resolution but are not as advantageous in either their axial resolution or temporal resolution because of their scanning criteria. TIRF microscopy provides the highest axial and temporal resolution compared with the other super-resolution microscope systems, although the imaging area is still 100-200 nm from the top surface of a cover slip. The common problem of these state-of-the-art technology is the cost of the apparatus, which prevents it from being standard equipment in basic laboratories. On contrast, our non-scanning-type, high-resolution imaging method using nanoparticle LSPR is very user-friendly and effective tool for monitoring nano interfacial phenomena. This technique will open the possibility for all biochemists and medical scientists to perform state-of-the-art molecular imaging using their own conventional microscope.

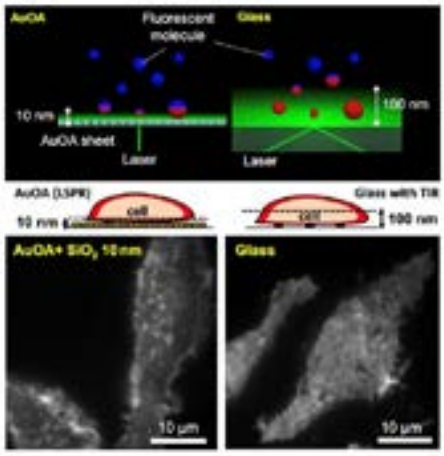


Figure: (a) Schematic drawing of the depth of the LSPR on the AuOA sheet and evanescent fields on glass. (b) Fluorescence images of FITC-labeled actin filaments in RBL-2H3 cells on the AuOA sheet (left) and on glass(right).

Recent Publications

- S Masuda et. al. (2017) High-resolution imaging of a cell-attached nanointerface using a gold-nanoparticle two-dimensional sheet. Sci. Rep. 7:3720.
- M Toma et. al. (2011) Collective plasmon modes excited on a silver nanoparticle 2D crystalline sheet. Phys. Chem. Chem. Phys. 13(16):7459-7466.
- D Tanaka et. al. (2015) Characteristics of localized surface plasmons excited on mixed monolayers composed of self-assembled Ag and Au nanoparticles.
- K Okamoto et. al. (2016) Electromagnetically induced transparency of a plasmonic metamaterial light absorber based on multilayered metallic nanoparticle sheets. Sci. Rep. 6:36165

Biography

Kaoru Tamada is a Scientist in the field of Surface Science and Nanoscience. After 7 years of R&D experience in industry, she joined Prof. Hyuk Yu's lab in Univ. of Wisconsin-Madison and obtained Dr. Sci. at Nara Women's University in 1994. After Postdoc experience in Riken, she worked as a Senior Scientist in AIST Japan for 10 years. During this period, she joined ANU, MPIP and NUS as a Visiting Scientist. She joined TokyoTECH in 2005 as an Associate Professor, and RIEC, Tohoku Univ. in 2007 as a Professor. She moved to IMCE, Kyushu Univ. in 2011, and was promoted to Vice President from 2017. Her research interest is self-assembly of molecules and nanomaterials, plasmonics, and their bio-sensor and bio-imaging applications.

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Cecile Reynaud et al., Mater Sci Nanotechnol 2017, 1:2

Growth of vertically aligned carbon nanotubes on metallic surfaces

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[2]NawaTechnologies, France

[3]LSI-Ecole Polytechnique, Université Paris-Saclay, France

Forests of vertically aligned carbon nanotubes (VACNTs) are attractive nanomaterials because of their unique structural, electrical and thermal properties. However, many applications require their growth on metallic substrates. Catalytic chemical vapor deposition (CCVD) is the best method to grow them but the catalytic particles can diffuse rapidly into the metal subsurface and thus become inactive. In this communication, I will address this issue through the recent results obtained in our laboratory. I will show how it is possible to grow VACNT on carbon fibers, stainless steel and aluminum surfaces by a single-step process, namely the aerosol assisted CCVD method, where the catalyst and carbon precursors are injected simultaneously. In the case of aluminum, due to its low melting temperature, the synthesis of VACNT requires a significant reduction in the growth temperature as compared to conventional substrates. Our results show that, with our single-step process, it is possible to obtain clean, long and dense VACNTs, with a growth rate at the best level compared to the state of the art at such low temperature. A particular attention has been paid to the study of the CNT/Al interface with various analysis technics: SEM, TEM, EDX, XPS, GDOES. The results suggest the crucial role of the interface for an efficient and reproducible VACNT growth. Finally, I will show that the aerosol-assisted CCVD process can be scaled-up to enable the fabrication of innovative ultracapacitors based on VACNTs grown on aluminum foils.

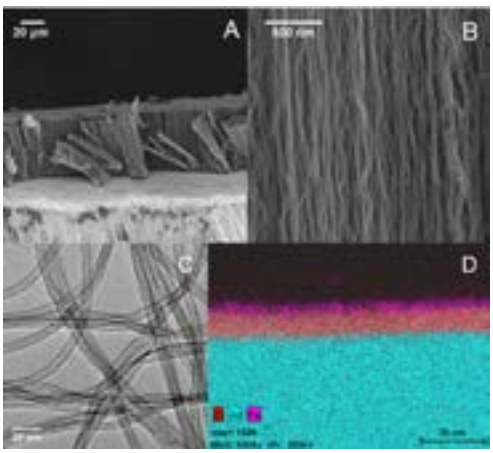

Figure: SEM (A, B) and TEM (C) images of VACNT on aluminum substrate. STEM/EDX (D) image of CNT/Al interface (blue: aluminum, red: oxygen, purple: iron).

Recent Publications

- M Delmas, M Pinault, S Patel, D Porterat, C Reynaud, M Mayne L'Hermite (2012) Growth of long and aligned multi-walled carbon nanotubes on carbon and metal substrates. Nanotechnology. 23(10):105604.
- P Landois, M Pinault, S Rouzière, D Porterat, C Mocuta, E Elkaim, M Mayne L'Hermite, P Launois, In situ time resolved wide angle X-Ray diffraction study of nanotube carpet growth: nature of catalyst particles and progressive nanotube alignment. Carbon. 7:0-10.
- C Castro, M Pinault, D Porterat, C Reynaud, M Mayne L Hermite. The role of hydrogen in the aerosol-assisted chemical vapor deposition process in producing thin and densely packed vertically aligned carbon nanotubes. Carbon. 61:585-594.
- P Boulanger, L Belkadi, J Descarpentries, D Porterat, E Hibert et. al. (2013) Towards large scale aligned carbon nanotube composites: an industrial safe-by-design and sustainable approach. J. Phys. Conf. Ser. 429:(1):1-12.
- S Lagoutte, P H Aubert, M Pinault, F O Tran Van, M Mayne-L 'Hermite, C Chevrot (2014) Poly(3-methylthiophene)/vertically aligned multi-walled carbon nanotubes: electrochemical synthesis, characterizations and electrochemical storage properties in ionic liquids. Electrochim. Acta. 130:754-765.

Biography

Cecile Reynaud has her expertise in the synthesis and chemical physics of nanomaterials. Her work has mainly dealt with silicon nanocrystals and aligned carbon nanotubes. She was the head of the Laboratory of Nanometric Assemblies (LEDNA) in the fundamental research division of the Saclay CEA center for 15 years. The LEDNA group follows the "bottom-up" approach of nanosciences. It develops its own synthesis methods for the elaboration of nano-objects and nanostructured materials with well-controlled characteristics. The processes of their formation and the characterization of their properties, especially those induced by size effects, are studied. The applications derived from these activities are relevant for energy, health, environmental issues and the development of composite materials. Another strong feature of the group is the up-scaling of synthesis processes in order to favor industrial transfer.

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Jonathan Cramer, Mater Sci Nanotechnol 2017, 1:2

Thermal plasma extractive metallurgy for e-waste recycling

Jonathan Cramer
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Recycling processes are now widely recognized as one of the solutions against the primary mineral resources supply risk. The most developed countries are aware of this issue and aim to find innovative processes to recycle strategical metallic elements. The existing processes are pyro and/or hydrometallurgical processes, however they may face significant drawbacks. Within the framework of alternative new recycling processes, we use the thermal plasma media to perform extractive metallurgy. Indeed, the so-called 4th state of matter combines the properties of hydro and pyro-metallurgical processes in addition to its particular properties. The selective extraction and recovery of desired metal in binary/ternary samples alloys (FeCu, CuSn, CuSnIn) has been carried out by a 15kW enhanced plasma process. The enhancement lies in the modification (additives) and the control of the hot plasma chemical reactivity and temperature. The liquid alloy mass transport is also studied and controlled (by a DC bias) in order to understand the plasma-alloy interface and optimize the extraction. The extracted elements are transported by the plasma flow and recovered by condensation on a capture plate. The understanding and the control of the plasma-alloy interface led to the selective extraction of the desired elements with a high purity. Some plasma thermodynamic tools have been conceived to improve the selectivity and extraction rate. Multiple diagnosis tools (OES, LIBS, DRX, ICP…) are employed in-situ and ex-situ so that an extraction mechanism can be proposed. The thermal plasma is a suitable media for metallurgical processes. In this project we used a customizable and controllable thermal plasma process to selectively extract and recover metal from binary/ternary alloys (Cu,Sn,In…), with the further objective to recycle strategic metals from more diverse and complex matrices.

Biography

Jonathan S. Cramer is a second year PhD student specialized in electrochemistry chemical engineering and material chemistry for applications in sustainable industries. During his Master studies he had the opportunity to work on topics such as: the durability of reinforced concrete building in the marine environment and the corrosion behaviour of hybrid aeronautic materials. Later on he focused on new alternative recycling processes destined to high value metallic wastes. Moreover, he worked as a research engineer on the set up of a molten salt electrochemical process for the recycling of super-alloys on end of life aircrafts. Now, as a PhD student, he investigates the implementation of a new thermal plasma process destined to the recycling of Waste Electrical & Electronic Equipment (WEEE).

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Notes:

Nicoleta Simionescu et al., Mater Sci Nanotechnol 2017, 1:2

Corrosion behavior of 316l stainless steel as biomaterial in physiological environment

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The field of biomaterials is considered as fascinating and challenging. It is fascinating because of its potential applications and the need to improve the quality of life. It is challenging due to the various complexities that is faces when biomaterials meet biological environments for longevity of life by maintaining or restoring tissues or organ functions. The stainless steels, especially 316L type is the most used metallic biomaterials for biomedical applications due to their good biocompatibility, low price, excellent corrosion resistance, availability, easy processing and high strength. Due to these favorable properties 316L stainless steel has become the most attractive biomaterial for dental implants, stents and orthopedic implants. In dentistry it is used in a variety of applications such as: temporary crowns, sterilized instruments, arch wires, brackets in orthodontics, etc. In vitro corrosion evaluation of an implant material in biological solution is the first step in biocompatibility characterization. The aim of this study is to evaluate the corrosion behavior of 316L stainless steel in two saliva solutions, with different pH values and chlorides content by electrochemical methods, in view of orthodontic applications. In situ electrochemical measurements as: open circuit potential (OCP), polarization resistance (Rp), potentiodynamic polarization (PD), cyclic voltammetry polarization (CV) and electrochemical impedance spectroscopy (EIS) were performed to monitor the corrosion process. The optical images of the tested samples have been observed before and after corrosion experiments using an optical microscope (Optika XDS-3 MET) to understand the nature of corrosion and the damages produced by this process.

Biography

Nicoleta Simionescu is a PhD student in Materials Engineering domain at Faculty of Engineering, Dunarea de Jos, University of Galati, Romania. Her field of study is the corrosion of metallic biomaterials in different environments which simulates the fluids of the human body.

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