Lecturer Award 2012 - 2013

Kislon Voïtchovsky

The Supramolecular Nano-Materials and Interfaces Laboratory – SuNMIL, Ecole Polytechnique Fédérale de Lausanne – EPFL, Lausanne

After receiving a Bachelor and a Master degree in Physics from the University of Lausanne (CH) – both with honor, Kislon Voïtchovsky obtained 2007 a DPhil in Biophysics from the University of Oxford (UK) with a thesis on the characterization of biomembranes by using AFM. Part of his thesis was done in collaboration with NTT basic research laboratory, Atsugi, and with the research group of Prof. Ando at Kanazawa University, both in Japan. He was granted the Arthur Cooke Prize of the University of Oxford Physics Department for his work. Dr. Voïtchovsky was 2008 –2010 as SNSF Post-doctoral Research Fellow at the MIT Massachusetts Institute of Technology (USA) where he worked on an experimental approach based on AFM to image and quantify solid-liquid interfaces with sub-nanometer resolution. He received 2009 the Nature Materials Award and 2011 the Ambizione Career Award of the Swiss National Science Foundation.

His research focused initially on the biomechanics and structure-function relationship of membrane protein studied with scanning probe microscopy. Given the importance of ionic effects on local hydration effects (interfacial effects with the surrounding liquid) he developed a strong interest in solid-liquid interfaces at the molecular level – he was awarded this FEMS prize with a lecture in this area.

Measuring wetting at the nanoscale

Solid-liquid interfaces (SLIs) occupy a central role in many phenomena ranging from surface electrochemistry to heterogeneous catalysis, heat transfer, proteins folding and function, ionic effects and molecular self-assembly. All these processes crucially depend on the particular structural arrangement of the liquid molecules close to the solid. This so-called interfacial liquid tends to be more ordered and dense than bulk liquid due to its interaction with the solid's surface. At the macroscopic level, these interactions are usually characterized by the work of adhesion W_{SL}, effectively the work necessary to separate the solid from the liquid. The wetting of the solid by the liquid is quantified by W_{SL}, with high values indicating good wetting.

Experimentally, SLIs are typically investigated through diffraction techniques and W_{SL} quantified with contact angle measurements. These techniques generally require averaging over large areas, hence rendering measurements particularly challenging for irregular SLIs, for example if the solid exhibits nanoscale domains with different affinities for the surrounding liquid.

These difficulties can be overcome using an approach based on amplitude-modulation atomic force microscopy (AM-AFM). When operated in a particular regime, AM-AFM can be used to gain semi-quantitative information about the local W_{SL} with sub-nanometer resolution. The approach effectively provides simultaneous maps of the interface topography and of the local wetting properties, often with atomic- or molecular-level resolution of the solid. The method has been successfully applied to study interfaces formed by liquids with minerals, biological membranes as well as synthetic nanostructures. The results show that molecular-level structural effects within the SLI can lead to unexpected macroscopic changes in the interface properties. This is the case for nano-patterned surfaces where nanoscale domains exhibiting dissimilar affinities for the liquid can to tune the surface wetting properties solely through the particular spatial organization of the different domains.

To be presented at EUROMAT 2013, Seville, Spain

Lecturer Award 2012 - 2013

Vincenzo Palermo

Nanochemistry Laboratory, CNR-Institute for Organic Synthesis and Photoreactivity – ISOF, Bologna, Italy

Vincenzo Palermo received a Master degree with honor in Industrial Chemistry in 1995 at the University of Bologna (IT). After working as a guest scientist at the University of Utrecht (NL), at Steacie Institute of the National Research Council (CND) and the research division of Procter & Gamble in Rome (IT) he obtained 2003 his Ph.D. in physical chemistry at the University of Bologna (IT) in a joint project with the CNR Istituto dei Composti del Carbonio ICOCEA also in Bologna. Vincenzo Palermo won two graduate student awards at the E-MRS Conference 2003 and at the European Conference on Molecular Electronics 2005; he received in 2006 the Young Scientist Award in materials science of the Italian Society for Microscopical Sciences (S.I.S.M.).

The initial area of interest of Dr. Palermo laid on the atomic-scale characterization of surfaces for microelectronic applications; his current work covers the production and nanoscale characterization of new materials for optoelectronics, photovoltaic applications and organic semiconductors as well as the fabrication of new materials by self-assembly and supramolecular chemistry of nanosized building blocks. He received this FEMS award with a lecture about the supramolecular functionalization of graphene.

Not a molecule, not a polymer, not a substrate... The many faces of graphene as chemical platform

What is, exactly, graphene?

While we often describe graphene with many superlative adjectives, it is difficult to force this (superlative) material within a single chemical class.

Graphene typical size is atomistic in one dimension of space, and mesoscopic in the others two. This provides graphene with several, somehow contrasting properties.

Graphene can be can be patterned, etched and coated as a substrate. Though, it can also be processed in solution and chemically functionalized, as a molecule. It could be considered a polymer, obtained by bottom-up assembly of carbon atoms, but it can be obtained from top-down exfoliation of graphite (a mineral) as well. It is not a nano-object, as fullerenes or nanotubes, because it does not have a well-defined shape; conversely, it is a large, highly anisotropic, very flexible object, which can have different shapes and be folded, rolled or bent to high extents.

In this presentation, we will discuss the state of the art and possible applications of graphene in its broader sense with a particular focus on how its “chemical” properties, rather than its well-known electrical ones, can be exploited to develop original science, innovative materials and new technological applications.

To be presented at EUROMAT 2013, Seville, Spain

TMS - FEMS Young Leader International Scholar Program

Amy J. Clarke

Materials Science and Technology – Metallurgy Group, Los Alamos National Laboratory, New Mexico, USA

Amy Clarke received her Bachelor of Science degree in Metallurgical and Materials Engineering from Michigan Technological University (MTU) in Houghton (MI, USA) and her Master of Science degree in Metallurgical and Materials Engineering from the Colorado School of Mines (CSM) in Golden (CO, USA). She was a visiting researcher in 2004 at the Laboratory for Iron and Steelmaking with Professor De Cooman at Ghent University (BE) and in 2005 with Professor Rizzo at the Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio) in Brazil. She received her Ph.D. in Metallurgical and Materials Engineering from the Advanced Steel Processing and Products Research Center (ASPPRC) at the Colorado School of Mines (CSM) in Golden (CO, USA) in 2006 for her dissertation entitled “Carbon Partitioning into Austenite from Martensite in a Silicon-Containing High Strength Sheet Steel”. Dr. Clarke has been granted several honors and awards, including: the Willy Korf Award for Young Excellence (2007) for her Ph.D. research, a TMS Young Leader Professional Development Award (2008), a TMS/Japan Institute of Metals Young Leader International Scholar (2010) award, and a United States Department of Energy Office of Science Early Career Research Program Award and a Presidential Early Career Award for Scientists and Engineers (PECASE) in 2012. Dr. Clarke was a G.T. Seaborg Institute Postdoctoral Fellow (2006-2008) and a Postdoctoral Research Associate (2009-2010) with the Metallurgy Group of Los Alamos National Laboratory (LANL) in Los Alamos (New Mexico, USA) and a Senior Development/Research Engineer (2008-2009) in Advanced Materials Technology at Caterpillar Inc. in Mossville (IL, USA). Since 2010, Dr. Clarke has been a Research and Development Scientist in the Metallurgy Group at LANL.

The research experience of Dr. Clarke includes in-situ analyses of materials using x-rays, neutrons, and protons at National User Facilities; the study of liquid-solid and solid-state phase transformations; the evolution of microstructure and properties associated with processing variations; and microstructure characterization of uranium, steel, and aluminum alloys.

Direct Interrogation of Metallic Alloys during Melting and Solidification

A solidification microstructure is the product of the processing path used to create it. Understanding this linkage is vital for structural materials because the solidification microstructure profoundly affects properties and performance. Destructive, post-mortem microstructure analysis can provide insight into what occurred at elevated temperatures, but in-situ observations during processing provide direct evidence as to how the microstructure evolves. Transparent organic analogs have been used to simulate solidification in metallic alloys in order to test aspects of solidification theory, but in-situ characterization techniques now afford direct interrogation of metallic alloys during synthesis and processing. In this work, synchrotron x-ray radiography/tomography and proton microscopy (first experiments) were used to directly interrogate small and large volumes, respectively, of metallic alloys during melting and solidification. These capabilities will permit the advancement of solidification theory, the development of predictive solidification and microstructure evolution models, and in-process adjustments through feedback systems to dynamically control microstructure evolution.

To be presented at EUROMAT 2013, Seville, Spain