

## Symposiums SS-TT-UU-VV

There are, perhaps, three components that are vital to the success of any scientific quest. They are – a creative thinking and a courageous experimentation of researchers in the field, a mix-up of this research with approaches of a broader research community (that one often creates most exciting ideas), and, finally, practical applications of the research that allows to put it in a broader perspective of our lives.

All these are distinctive features of four symposiums that were held at Fall MRS 2010 meeting in Boston are united in this volume, namely, Symposium SS: “Advanced Imaging and Scattering Techniques for In Situ Studies”, TT: “In Situ X-Ray Synchrotron Radiation Spectroscopies in Energy-Related Materials Science and Heterogeneous Catalysis”, UU: “Real-Time Studies of Evolving Thin Films and Interfaces” and VV: “Novel Development and Applications of Scanning Probe Microscopy”. A major unifying theme for these symposia is exploration of intricate properties of materials on the near-to-atomic length scale in the immediate vicinity of the free surface or at interfaces between materials. These symposia focus on various aspects and approaches of exploration of surfaces and interfaces from more traditional electron and x-ray scattering (focus of symposia SS, TT, and UU) to more recent and rapidly advancing scanning probe microscopy, or SPM (Symposium VV) and covered a field of high importance across the broad MRS community.

This is an area of tremendous interest in modern material science and an important aspect of nanotechnology as interfaces and surfaces become a dominant factor in determining properties and functionalities of a wide range of materials, including oxides, metals and nanoparticles. Monitoring evolving surfaces in real time is a prerequisite for mastering the evolution process itself, whether it is growth or other. Furthermore, surfaces and interfaces often display surprising properties that are qualitatively different to those of the corresponding bulk materials. Controlling and tailoring the physical properties at the interfaces and between different materials on the atomic scale can therefore result in real breakthroughs. Experiments towards atomic control when fabricating interfaces and surfaces will help to understand the important structure-property relations as well as enable the design of nano-devices. Another aspect is dedicated techniques that probe the structure and/or the properties of evolving surfaces and interfaces in environments when they are created and used..

The presentations of **Symposium UU** have been a forum for researchers who use or develop in situ characterization and monitoring techniques for thin films, surfaces and interfaces. Experts in the fields of real-time 1) scattering (e.g., XRD and TEM), 2) imaging (e.g., SPM) and 3) spectroscopy (e.g., XPS) were brought together to report on their respective progress and/or new developments. Different kinds of probes, as light in a wide energy spectrum, electrons and scanning probes have been presented and their different capability to adapt, case by case, to the very peculiar working conditions required for this research has naturally emerged. Also, a particular opportunity was created for researchers to show prospects of application of novel techniques to real-time analysis.

The search for new sources of clean energy is rapidly becoming one of the most pressing technological challenges that we are facing today with good representation at **Symposium TT**. At the same time, enormous progress has been made in developing new, tailored materials via nanostructuring, self-assembly and bio-mimetic methods, that are the key for developing renewable energy sources, such as solar energy conversion, as well as for the rational design of highly efficient catalysts. The effort requires new materials developed through the control of the atomic, chemical and electronic structure. Enabling such control of properties requires an intimate collaboration

between materials synthesis and characterization of the electronic properties of complex materials. The presentations at this symposium have shown the opportunities that synchrotron radiation research can provide to answer some of the challenges associated with energy science research, including exploration of high temperature superconductors, lithium ion batteries, fuel cells, to name a few. These materials come in a broad range of chemical and structural complexity, rendering their analysis and diagnostics difficult. Yet, a large number of critical issues relevant for energy purposes have been addressed with x-ray scattering and spectroscopy including devices in operation.

Finally, a symposium VV that focused on novel SPM related advances, that are a vital and, often, the only tool allowing precise imaging and characterization of certain nano-structures. The talks there spanned broad area from chemical identification at atomic resolution (Mohn, Pethica, Schwarz) and new probe functionalities (Ko, Westervelt, Ashby, Hong) to nanomechanical (Carpick, Hurley, Kolosov), thermal (Narayanaswamy, King), optical (Wickramasingh, Haugstad) and electrical (Bonnell, Kim, Kalinin, Shin) SPM measurements. Novel developments in nanomanufacturing (Weaver, King, Li) and new high speed and dynamic measurements (Besenbacher, Miles, Frenken, Huey) were as interesting, and showed its increasing impact on the future applications of SPM. The panel discussion chaired by Dawn Bonnell involved lead researchers of major scanning probe instrumentation companies, government agencies and leading researchers, touched upon the shortcomings, challenges and inspiration of this relatively young developing field.

The distinctive feature of Symposium VV was a panel of developers and users of SPM, that was chaired by Dawn Bonnell and involved lead researchers of major scanning probe instrumentation companies, government agencies and leading researchers, touched upon the shortcomings, challenges and inspiration of this relatively young developing field.

Given close link between all four sessions, we held several joint sessions between symposiums TT-SS and SS-VV allowing deep integration of research in this valuable area of Material Science. Overall our symposia brought together the leading edge expertise of variable characterization methods, nanoscale and advanced materials manufacturing and fundamental electronic and chemical properties of the materials involved. With a magnificent great selection of invited and contributed talks, eight large poster sessions and a panel discussion with the industry.

This joint preface was compiled by Oleg Kolosov, with contribution from all the editors of Symposiums SS, TT, UU and VV – namely, John Cumings, Dillon D. Fong, Jianyu Huang, Stuart Lindsay, Guangwen Zhou, Jinghua Guo, Hendrik Bluhm, Michael Hävecker, Shu Yamaguchi, Gertjan Koster, Fabio Miletto Granozio, Gyula Eres, Chang-Beom Eom, Nicholas Ingle, Seungbum Hong, Hyunjung Shin and Bryan D. Huey.

### **ACKNOWLEDGMENTS**

At our Symposiums we were extremely fortunate to have great invited speakers that presented their cutting edge research in this rapidly developing and indispensable for material science research area. We would like to express our gratitude to our Invited Speakers for the high scientific level and novelty of their contribution:

- Fleming Besenbacher, Dawn Bonnell, Robert Carpick, Yasuo Cho, Donna Hurley, Sergei Kalinin, Hyoungsoo Ko, Xiaodong Li, Sergei Magonov, Mervyn Miles, Fabian Mohn, Arvind Narayanaswamy, Christine Ortiz, Sang-il Park, John Pethica, Kumar Wickramasinghe

We also would like to thank Members of the Panel on Next-Generation SPM held at Symposium VV, namely,

- Robert Cook, Kevin Kjoller, John Pethica, Roger Proksch, Sang-il Park, Chanmin Su, Jane Zhu with particular thanks to the panel chair Dawn Bonnell.

The organizers would like to also thank all the speakers at the Symposiums, the session chairs, and the symposium assistants for their contribution to make the symposium a success. The organizers are grateful to the MRS editorial staff for their diligent work in organizing conference and assembling the volume.

And, finally, we gratefully acknowledge the very valuable financial support of the Symposium that allowed us to sponsor students and young researchers' participation:

- Asylum Research, INOSTEK Inc, K-TEK Nanotechnology, Park Systems, Bruker, SPECS Surface Nano Analysis GmbH, InSync, Inc

