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INVITATION

Symposium on Smart Materials and Applications on 23 October 2018
Giefinggasse 4, 1210 Vienna, Austria

The AIT Austrian Institute of Technology cordially invites to the

SYMPOSIUM ON SMART MATERIALS AND APPLICATIONS

Time: Tuesday, 23 October 2018, 1 pm
Place: Giefinggasse 4, 1210 Vienna, room M5A + M5B

Agenda

1:00 pm **Welcome** Wolfgang Knoll, AIT Austrian Institute of Technology

Chair: **Hartmut Kahlert**, TU Graz

1:15 pm **Zhenan Bao,** Stanford University, California
Skin-Inspired Electronics

2:00 pm **Ulrich S. Schubert,** Friedrich-Schiller-University, Jena, Germany
Polymer-Based Batteries: From Printable Thin Film Batteries to Stationary Redox Flow Batteries

2:45 pm **Bettina V. Lotsch,** MPI for Solid State Research, Stuttgart, Germany
2D or not 2D? Two-Dimensional Nanostructures for Sensing and Energy Conversion

3:30 pm **Coffee Break**

Chair: **Corina Täubert**

4:15 pm **A. Paul Alivisatos,** University of California at Berkeley, California
From Scaling Laws to Practical Light Emitters: Quantum Dot Science and Technology

5:00 pm **Niyazi Serdar Sariciftci,** Johannes Kepler University, Linz, Austria
Bioorganic Semiconductors for Sustainable Optoelectronic Devices and Bio-Integration

6:00 pm **Departure for dinner**

ABSTRACTS OF THE SPEAKERS

Zhenan Bao
Stanford University, California

Skin-Inspired Electronics

Skin is the body's largest organ, and is responsible for the transduction of a vast amount of information. This conformable, stretchable, self-healable and biodegradable material simultaneously collects signals from external stimuli that translate into information such as pressure, pain, and temperature. The development of electronic materials, inspired by the complexity of this organ is a tremendous, unrealized materials challenge. However, the advent of organic-based electronic materials may offer a potential solution to this longstanding problem.

My group has been working on understanding of the fundamental design principles of new electronic materials that have skin-like properties, such as stretchability, self-healing ability and biodegradabaility while maintaining excellent electronic properties. We realized artificial skin with sensitivity and stretchability comparable to that of human skin. We demonstrated artificial mechanoreceptors and artificial nerve systems. In turn, the basic inventions of materials and devices enabled a new generation of skin conformal electronics that can be used for health monitoring wearables, wireless and biodegradabale implantable sensors for tendon repair and neuroprostheses.

Ulrich S. Schubert
Center for Energy and Environmental Chemistry Jena (CEEC Jena), Friedrich-Schiller-University Jena, and Max Planck Institute of Colloids and Interfaces, Research Campus Golm, Potsdam, Germany

Polymer-Based Batteries: From Printable Thin Film Batteries to Stationary Redox Flow Batteries

For renewable energy sources such as solar, wind, and hydroelectric to be effectively used in the grid of the future, flexible and scalable energy-storage solutions are necessary to mitigate output fluctuations. For systems that are intended for both domestic and large-scale use, safety and cost must be taken into account as well as energy density and capacity, particularly regarding long-term access to metal resources, which places limits on the lithium-ion-based and vanadium-based RFB development. Here we describe an affordable, safe, and scalable battery system, which uses organic polymers as the charge-storage material in combination with inexpensive dialysis membranes, which separate the anode and the cathode by the retention of the non-metallic, active (macro-molecular) species, and an aqueous sodium chloride solution as the electrolyte. In parallel, printable solid-state polymer batteries were developed allowing a new generation of metal-free batteries (e.g. with application possibilities for smart labels, internet of things or smart clothes).

Bettina V. Lotsch
Max Planck Institute for Solid State Research, Stuttgart, Germany

2D or not 2D? Two-Dimensional Nanostructures for Sensing and Energy Conversion

The discovery of graphene, along with the early achievements of *Chimie Douce* and nanotechnology, has led to a resurgence of interest in layered materials which display a virtually unlimited source of 2D materials of all stripes. The operation of classical and quantum size confinement effects in dimensionally reduced materials offers a unique basis for accessing new properties and reactivity profiles distinct from those found in their bulk counterparts. In addition, the combination of different 2D materials to form superlattices with synergistic properties is the next step forward to access complex heterostructures which are not only key elements in miniaturized devices, but, if scalable, offer new design principles for bulk "artificial solids" with properties engineered on the nanoscale. In this talk, I will describe the synthesis, characterization and properties of selected 2D materials and highlight their potential for applications in solar energy conversion and chemo-optical sensing. Examples include humidity-responsive transition metal phosphate nanosheets as ultrasensitive humidity sensors and active elements in touchless positioning interfaces, and a new generation of 2D carbon-based photocatalysts for the hydrogen evolution reaction, which are able to "store" photogenerated electrons for the time-delayed production of solar fuels.

A. Paul Alivisatos
University of California at Berkeley, California

From Scaling Laws to Practical Light Emitters: Quantum Dot Science and Technology

Quantum Dots have emerged as practical light emitters with valuable applications in biological imaging and electronic displays. They arose through the systematic exploration and marriage of the physical scaling laws of nanoscience with practical innovations in chemical synthesis. This talk will touch upon some of these principles that allow us to exploit quantum dots as light emitters, for instance the variation of melting temperature vs. size, the facile exclusion of defects and impurities form nanocrystals, and the quantum size effect on the band gap energy.
Today we are working on a new challenge to harness these light emitters for applications in solar energy harvesting. In a quantum dot, every effort is made to fully confine photo-generated electron-hole pairs within the dot, so that they will emit light with unity quantum efficiency. That in itself makes them hard to use for solar photovoltaics, where the photo-generated electrons and holes must be readily extracted. Instead of making a photovoltaic, we are exploring quantum dot luminescent concentrators. In such a device, quantum dots are specially designed to absorb broadband diffuse light and to concentrate it more than any geometric lens can do.
This control of photon entropy can be achieved in theory when the quantum dots are embedded inside a properly designed photonic cavity. This talk will review our recent progress towards the practical realization of solar energy harvesting quantum dot luminescent concentrators.

Niyazi Serdar Sariciftci
Linz Institute for Organic Solar Cells (LIOS) at the Johannes Kepler University of Linz, Austria

Bioorganic Semiconductors for Sustainable Optoelectronic Devices and Bio-Integration

Bio-organic electronics is emerging rapidly in the scientific literature. Generally, bioelectronics has been a dream of cybernetics for quite some time. The pioneering work of Peter Fromherz (Max Planck Institute for Biochemistry) interfacing the neurons with silicon circuits go back several decades. However, the bioelectronics has been limited to silicon based electronic circuits for quite some time. Recently, the discovery of organic semiconductor devices has opened up a new avenue to realize this dream of biological interfacing with electronic circuits.

Organic semiconductors, especially bio-organic, bio-compatible semiconductors display a list of properties which are important for the interfacing of biological systems with electronic world: Their biocompatibility, non-toxicity, processability and operational stability in aqueous media are often much better than the inorganic counterparts.

To make an interface with biosystems, the transformation of the electrical information into ionic and protonic information is necessary. Biosystems are often based on ionic transport and signal transduction based on electrochemical systems as opposed to electronic world which use normally the electronic conduction based on solid state physics. In such transformation of the signal from electronic world to the bio-world, we need materials and systems as transducers, which can sustain electronic as well as ionic conduction. Organic semiconductors can offer this possibility. Therefore, we suggest that the future of cybernetics might be using more and more organic/bio-organic semiconductors.

On the other hand, the green electronics is also important to sustain a sound and healthy environment. We have already a problem with our electronic waste in the world today. Humanity is today not able to create a sustainable cycle for production, use and end-of-life of our electronic gadgets and instruments. Often such highly valuable products are landing in ordinary garbage dumps, polluting the environment, wasting highly valuable and precious materials as well. Akio Morita, the founding chairman of SONY has once stated:

> "We are moving from consumer electronics to consumable electronics".

Upon this premise we can clearly see that the electronic waste is and will be an increasing problem. By using plastic materials for organic solar cells, organic light emitting diodes etc, we will face a surmounting problem of plastic waste, which is already polluting our oceans. Polyolefins and commodity plastics are often not bio-degradable and impose a problem when they end up in biosphere.

For all these problems, we can suggest the use of bio-degradable and non-toxic bio-organic semiconductors as a sound alternative.