

DS 20: Organic Polymer-Metal Interfaces (SYSA 7)

Time: Wednesday 17:45–19:30

Location: H 2013

Invited Talk DS 20.1 Wed 17:45 H 2013
Designing the nanostructure of the organic polymer - metal interface — ●STEPHAN V. ROTH — HASYLAB at DESY, Notkestr. 85, D-22607 Hamburg, Germany

Thin film organic-metallic nanocomposites play an important role in biosensing [1], solar cell applications [2] or organic electronics [3]. Depending on the desired application, one must tailor the interface metal - organic layer, e.g. selective contacting [4] or exploiting the plasmon resonances of the nanostructured metal layer [2,5,6]. Therefore, understanding the growth kinetics of the nanoparticle layer during deposition is of utmost importance to be able to design the nanocomposites' properties [6].

We exploited different deposition methods ranging from vacuum deposition [5,7] to solution casting [8] to install different metal layer morphologies. In combination with grazing incidence small-angle x-ray scattering we were able to observe the metal nanolayer growth kinetics on different organic and inorganic layers in real-time and present first results.

- [1] B. Dubertret et al., Nat. Biotechnol. 19, 365 (2001)
- [2] M. Westphalen et al., Sol. Energy Mater. Sol. Cells 61, 97 (2000)
- [3] S. Gamerith et al., Adv. Funct. Mater. 17, 3111 (2007)
- [4] T. L. Morkved et al., Appl. Phys. Lett. 64, 422 (1994)
- [5] S.V. Roth et al., Appl. Phys. Lett. 88, 021910 (2006)
- [6] A. Biswas et al., Vac. Techn. & Coat. 7, 54 (2006)
- [7] S.V. Roth et al., Appl. Phys. Lett. 82, 1935 (2003)
- [8] S.V. Roth et al., Appl. Phys. Lett. 91, 091915 (2007)

DS 20.2 Wed 18:15 H 2013
Photovoltaic effect in layer-by-layer self-assembled composite films of TiO₂ nanoparticles, polymers and quantum dots — ●ROLF KNIPRATH¹, JAMES T. MCLESKEY JR.², JÜRGEN P. RABE¹, and STEFAN KIRSTEIN¹ — ¹Humboldt University Berlin — ²Virginia Commonwealth University, Richmond

We report on the properties of thin film hybrid photovoltaic devices with sensitized nanoporous TiO₂ anodes and polymeric hole transport layers (HTL). The TiO₂ films were grown with a layer-by-layer self-assembly process that relies on electrostatic interaction between inorganic particles and charged polymers. This method provides a simple means to incorporate sensitizer materials such as semiconductor quantum dots or light absorbing polymers during the film growth.

We fabricated two types of devices. One employs a novel, water-soluble polythiophene derivative which acts both as a sensitizer and as a HTL, the other uses strongly light absorbing CdTe and CdSe quantum dots as sensitizers and a highly conductive transparent polymer as a HTL. Both types of devices were grown on glass substrates coated with bilayers of transparent fluorine-doped tin oxide (FTO) and compact TiO₂. Evaporated gold electrodes served as back contacts. Current-voltage-measurements under white light and in the dark showed a pronounced photovoltaic effect for both systems and yielded photovoltages of up to 0.80V for the polythiophene devices and 1.1 V for the quantum dot devices.

DS 20.3 Wed 18:30 H 2013
Immobilization of nanoparticles on polymer brushes for nanosensors — ●SMRATI GUPTA¹, PETRA UHLMANN¹, ULRICH OERTEL¹, NIKOLAI GAPONIK², ALEXANDER EYCHMÜLLER², and MANFRED STAMM¹ — ¹Leibniz-Institut für Polymerforschung Dresden e.V., Hohe Strasse 6, 01069 Dresden, Germany — ²Technische Universität Dresden, Physikalische Chemie-Elektrochemie, 01062, Dresden, Germany

We report on the immobilization of nanoparticles (Au, Ag or CdTe) on responsive polymer brushes by covalent or electrostatic interactions. Atomic force microscopy (AFM) was used to study the film morphology. The presence of nanoparticles on the polymer brushes was proved by X-ray photoelectron spectroscopy (XPS). Changes in optical properties of quantum dots/metal nanoparticles after the immobilization was studied by photoluminescence or UV-VIS spectroscopy. The exploitation of such polymer brushes revealed suppressed nanoparticle aggregation and facilitated complete surface coverage. Finally, the systems were used to fabricate nanosensors for solvents or for the pH of the surrounding aqueous medium. The concept is based on the variation of the photoluminescence with changing interparticle distance due

to the swelling/deswelling of the responsive polymer brushes.

DS 20.4 Wed 18:45 H 2013
Near Infrared Sensitivity of PbS Quantum Dot Sensitized Organic Photodiodes — ●TOBIAS RAUCH^{1,4}, MICHAELA BÖBERL^{1,2}, MAKSYM KOVALENKO³, SANDRO TEDDE¹, ULI LEMMER⁴, JENS FÜRST⁵, WOLFGANG HEISS³, and OLIVER HAYDEN¹ — ¹Siemens AG, CT MM 1, D-91058 Erlangen, Germany — ²CD Laboratory for Surface Optics, Universität Linz, A-4040 Linz, Austria — ³Institute of Semiconductor and Solid State Physics, Universität Linz, A-4040 Linz, Austria — ⁴Light Technology Institute, Universität Karlsruhe (TH), D-76131 Karlsruhe — ⁵Siemens AG, MED RVV, D-91058 Erlangen, Germany

Composites of colloidal semiconductor quantum dots (QDs) and semiconducting polymers expand the sensitivity of organic photodetectors beyond the visible spectrum (> 780 nm).

Blending the photoactive P3HT:PCBM layer of our bulk heterojunction photodetectors with near-infrared sensitive PbS QDs pushes the spectral response of the detector up to wavelengths of 1500 nm. The QDs show a photoconductive gain linearly increasing with the bias voltages. At 1300 nm, the photodetectors yield external quantum efficiencies of 8% remaining constant over more than 3 decades of irradiation intensity. Good signal-to-noise ratios can be achieved for signals up to 10 kHz.

The sensitization of organic photodetectors with colloidal QDs enables organic optoelectronics to enter the field of IR related applications like IR imaging, security sensing and scanning.

DS 20.5 Wed 19:00 H 2013
Interface engineering and advanced photon harvesting in organic solar cells — ●ROBERT KOEPE¹, PAVEL A. TROSHIN², RIMMA N. LYUBOVSKAYA², and N. SERDAR SARICIFTCI¹ — ¹Linz Institute for Organic Solar Cells (LIOS), JKU Linz — ²Institute of Problems of Chemical Physics, Russian Academy of Science, Chernogolovka

We consider two approaches towards increasing the photon harvesting in low energy gap organic solar cells. These devices usually have a low absorption cross section in the blue and green part of the spectrum, which decreases the quantum efficiency in this range. Both approaches require a tuning of the interfaces between the active materials in the device. Firstly, we use the complexing of a pyrrolidinofullerene with pendant pyridil groups to zinc-phthalocyanine to specifically organize the interfaces in a multicomponent organic solar cell. [P.A. Troshin et al., Chem. Mater. 19, 5363 (2007)] Secondly, we consider the use of CdSe/ZnS semiconductor nanocrystals as energy transfer donors that channel the energy from the absorbed light onto the active material of the solar cell. Here, the ligand shell around the nanocrystals plays an important role to insulate the crystals and still allow energy transfer. The dependence of the energy transfer efficiency on the length of the ligands is determined and a photodiode device made of zinc-phthalocyanine is presented, where the addition of CdSe/ZnS nanocrystals lead to an enhanced sensitivity in the green spectral region. [R. Koepe et. al., Sol. Energ. Mat. Sol. Cells 91(11), 986 (2007)]

DS 20.6 Wed 19:15 H 2013
In-Situ Investigations of Si/Polypyrrole Interfaces by Pulsed Photoluminescence and IR Spectroscopic Ellipsometry — ●CARL MATTHIAS INTELTMANN¹, VITALI SYRITSKI², KARSTEN HINRICHS³, and JÖRG RAPPICH¹ — ¹Hahn-Meitner-Institut Berlin GmbH, Department Silicon Photovoltaics (SE1), Berlin, Germany — ²Tallinn University of Technology, Department of Materials Science, Tallinn, Estonia — ³ISAS - Institute for Analytical Sciences, Department Berlin, Germany

Conducting polymers - such as polypyrrole (PPy) - offer a unique combination of properties, which are interesting for photovoltaic applications. Important - especially - for solar cells is a low recombination rate of charge carriers at the silicon interfaces, which can be inspected by the band gap related photoluminescence (PL). We used pulsed PL techniques to investigate the recombination behaviour at the Si/PPy interface. The PPy films were directly deposited on Si substrates by electrochemical methods.

Our ex-situ and in-situ PL investigations show that PPy films on Si surfaces lead to well passivated Si interfaces. Ex-situ infrared spec-

troscopic ellipsometry (IR-SE) measurements yielded a thickness of approx. 45 nm of the ultrathin PPy films. Additionally performed | in-situ IR-SE measurements show negligible formation of SiO_x species at the Si/PPy interface.