

Tuesday Evening Poster Sessions, November 4, 2003

Contacts to Organic Materials Topical Conference Room Hall A-C - Session OM-TuP

Poster Session

OM-TuP1 Study of Surface Photovoltage Effects in Doped Organic Molecular Thin Films, C. Chan, W. Gao, A. Kahn, Princeton University

We investigate photoemission-induced surface photovoltage (SPV), i.e. non-equilibrium resulting from photoexcitation and separation of carriers, in organic films. We focus on electrically doped molecular films that exhibit interface depletion regions¹ and can sustain charge separation and SPV. We combine ultraviolet photoemission spectroscopy (UPS) to measure the HOMO and vacuum levels under illumination, and contact potential difference (CPD) measurement with a Kelvin probe to measure the vacuum level in the dark. Zinc phthalocyanine (ZnPc) and N,N'-diphenyl-N,N'-bis(1-naphthyl)-1,1'-biphenyl-4,4'-diamine (α -NPD) p-doped with the acceptor molecule, tetrafluorotetracyanoquinodimethane (F₄-TCNQ), are investigated.^{1,2} UPS and CPD measurements are performed as a function of film thickness deposited on Au. CPD measurements reproduce with excellent accuracy the UPS-observed shifts of the molecular energy levels, in particular through a depletion region ~30-50 Å near the metal-organic interface of the doped organic films. The excellent agreement shows that: (1) efficient p-doping occurs even in the dark in these two organic systems; (2) SPV is negligible in both doped and undoped organic films. The undoped films do not have depletion regions where charge separation can occur. In the doped films, electrons separated in the interface depletion region recombine in the metal before generating significant SPV, whereas the holes readily recombine throughout the film.¹ W. Gao and A. Kahn, Organic Electronics 3, 53 (2002)² W. Gao and A. Kahn, J. Appl. Phys. (accepted for publication; July 1, 2003).

OM-TuP2 Adsorption of PTCDCA on Si(100), B. Grandier, T. Soubiron, J.P. Nys, M. Dubois, C. Delerue, D. Stievenard, IEMN-CNRS, France

Submonolayer coverages of perylene-tetracarboxylic-dianhydride (PTCDA) molecules have been investigated with scanning tunneling microscopy (STM) and X-ray photoelectron spectroscopy (XPS). At low coverage, comparisons between the STM images and calculations of the electronic structure of the molecule show that the molecule adsorbs mostly in a planar configuration with its axis parallel to the Si dimers. Different configurations are observed and associated with physisorbed and chemisorbed states of the adsorbates. At higher coverage, X-ray measurements indicate that only a fraction of the molecules are chemisorbed and that the bonding occurs through the dicarbonyl functional groups, preserving the pi-conjugation of the molecules. While PTCDA selectively reacts with the Si dimers, steric hindrance is found to be the major cause to hamper the formation of an ordered film.

OM-TuP3 Potential Imaging of Metal-organic Semiconductor Interfaces using Kelvin Probe Force Microscopy, O. Tal, Tel Aviv University, Israel; W. Gao, L. Friedman, A. Kahn, Princeton University; Y. Rosenwaks, Tel Aviv University, Israel

Understanding and improving the performance of organic electronic devices depends, to a great extent, on the elucidation of organic materials interfaces with inorganic and organic solids alike. Therefore these interfaces are the focus of this work. We present a study of two dimensional (2-D) potential profiles across metal-organic film interfaces (metal- Au or Al, organic film - tris(8-hydroxyquinolino) aluminum [Alq₃]) with nanometer spatial resolution provided by Kelvin probe force microscopy (KPFM) in a nitrogen environment. The contact potential difference (CPD) is measured across Al/Alq₃/Al, Au/Alq₃/Au and Au/Alq₃/Al sandwich-like structures following cleavage under the inert atmosphere. The CPD profiles are in a very good agreement with vacuum level profiles estimated by calculation, which are based on ultraviolet photoemission spectroscopy (UPS) measurements. Preliminary measurements of these structures and "device-type" structures under operating conditions will be presented and discussed. This work is the first step in providing a new and unique type of information on the electronic structure of metal-organic and organic-organic interfaces, as determined by KPFM and additional techniques.

OM-TuP4 Conductive Core-Shell Nanoparticles: An Approach to Self-Assembled Mesoscopic Wires, G. Kaltenpoth, M. Himmelhaus, Universität Heidelberg, Germany; L. Slansky, Daimler-Chrysler AG, Germany; F. Caruso, University of Melbourne, Australia; M. Grunze, Universität Heidelberg, Germany

Conductive core-shell nanoparticles were prepared by coating negatively charged monodisperse polystyrene (PS) latex spheres with a thin layer of polyethyleneimine (PEI). Subsequently, gold colloid with 3 nm in size was electrostatically adsorbed onto the PEI-coated spheres, and finally, an electroless gold plating step was repeatedly carried out to yield a high gold coverage and thus a conductive gold shell. The metallic behavior was investigated by XPS and UV-vis. In the XPS Au4f peak, a shift due to charging effects was observed at low metal coverage, which decreased with increasing gold decoration, and vanished with the formation of a conductive metal shell. The UV-vis spectra show a coverage-dependent shift and broadening of the Au plasmon resonance. The self-assembly of the metal coated spheres into continuous lines was investigated to explore the applicability of such particles to realize self-assembled electrical circuits. It was found that the particles selectively adsorb to the carboxyl-terminated areas of line patterns fabricated by microcontact printing of alternating carboxyl- and methyl terminated alkanethiolates on gold.

OM-TuP5 The Enhancement of Passivation Effect and Long Time Stability on Aluminum Cathode Deposited by Adatom Mobility Enhancing Technique in Organic Electroluminescent Display, S.M. Jeong, W.H. Koo, S.H. Choi, Yonsei University, Korea; S.J. Lee, Kyung Seong University, Korea; K.M. Song, Kon Kuk University, Korea; H.K. Baik, Yonsei University, Korea, South Korea

Highly stable and electroluminescent devices based on spin-coated PPV thin films have been achieved. The improvement of lifetime is derived from aluminum cathode deposited by adatom mobility enhancing technique. There are much less pinhole defects because of fine grain size caused by high surface mobility and contact area between Al and PPV increase. It is believed that the passivation effect and minimizing thermal degradation is induced by much less pinhole defect and large contact area between Al and PPV.

OM-TuP6 Hole-injection and Transport in Arylamines Films Sandwiched between Metal Contacts, G. Szulcowski, J. Li, K.-Y. Kim, J. Sun, S.C. Blackstock, University of Alabama

We have synthesized a series of electron-rich arylamines to systematically control their electronic properties, i.e. dipole moment and ionization potential. Films of these molecules were made by solution and/or vapor deposition techniques on Ag and Au substrates and characterized by cyclic voltammetry and x-ray photoelectron spectroscopy. We have measured current-voltage curves of monolayer and multilayer films to study hole-injection and transport. We find that these molecules rectify current under forward bias above a threshold voltage. A plot of the threshold voltage against the measured electrochemical oxidation potential yields a straight line with an excellent correlation coefficient, $R = 0.98$, and slope greater than unity. We will discuss how the molecular properties influence charge-injection at the metal-molecule interface. We acknowledge the National Science Foundation for support of this work through the Materials Research Science and Engineering Center grant # DMR0213985.

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