DS 5: Organic Thin Films

Time: Monday 17:45–19:15 Location: H 2013

DS 5.1 Mon 17:45 H 2013

Functionalization of (0001) 6H-SiC with organic silanes — •Sebastian Schoell, Marco Hoeb, Ian Sharp, Martin Stutzmann, Martin Eickhoff, and Martin S. Brandt — Walter Schottky Institut, Technische Universität München, 85748 Garching, Germany

Due to its extraordinary physical properties and chemical stability SiC is a promising material for biosensor applications. The affinity of SiC to form OH-terminated surfaces by wet chemical treatments is exploited to generate functional layers via silanization with organic molecules on SiC. In particular, wet chemically processed layers of ODTMS and APDEMS on n-type (0001) 6H-SiC were investigated. The structural and chemical properties of these layers were studied by contact angle measurements, atomic force microscopy (AFM), thermal desorption spectroscopy (TDS), and X-ray photoelectron spectroscopy (XPS). The organic layers are smooth and change their wettablity depending on the molecules used. Desorption temperatures in the range of 550°C indicate covalent bonding of the organic molecules to the SiC surface. Starting from monolayers with amine functional groups, the possibility of attaching complex molecules was demonstrated by immobilizing proteins on micropatterned organic layers followed by direct imaging via fluorescence microscopy.

DS 5.2 Mon 18:00 H 2013

Electronic properties of self-assembled organic monolayers on Ge surfaces — •Ian Sharp, Sebastian Schoell, Marco Hoeb, Martin S. Brandt, and Martin Stutzmann — Walter Schottky Institut, Technische Universität München, 85748 Garching, Germany

Ge surfaces and interfaces are commonly characterized by high densities of electrically active defect centers which severely limit the performance of Ge-based devices. Here, we investigate the electrical properties of metal-insulator-semiconductor (MIS) structures consisting of self-assembled alkyl monolayer-based insulating layers. Alkylation of the surface is achieved via thermal hydrogermylation of hydrogen terminated n-type (100) and (111) Ge with 1-octadecene, which is analogous to the well-known hydrosilylation reaction on Si. Chemical and structural characterization by thermal desorption spectroscopy (TDS), water contact angle measurements, and x-ray photoelectron spectroscopy (XPS) is performed and reveals covalently bound and tightly packed organic monolayers. Current-voltage (IV) measurements show strong rectifying behavior, although relatively large reverse bias saturation currents were observed. Capacitance-voltage (CV) measurements on both highly and nominally n-doped samples reveal Fermi-level pinning of functionalized surfaces at 0.2 eV below the conduction band edge. However, no slow-state charge trapping is observed and saturation capacitance behaviors are indicative of high quality insulating layers.

DS 5.3 Mon 18:15 H 2013

Anisotropic optical function of diindenoperylene thin films determined by ellipsometry — •Ute Heinemeyer[1], Reinhard Scholz[2], Linus Gisslen[2], M. Isabel Alonso[3], J. Oriol Ossó[3], Miquel Garriga[3], Alexander Gerlach[1], and Frank Schreiber[1] — [1]Institut für Angewandte Physik, Auf der Morgenstelle 10, 72076 Tübingen — [2]Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, 85748 Garching — [3]Institut de Ciència de Materials de Barcelona, CSIC Esfera UAB, 08193 Bellaterra, Spain

Diindenoperylene (DIP) has received increased attention due to its well defined ordering and promising electronic transport properties. Furthermore DIP exhibits a well-defined vibronic progression of the HOMO-LUMO transition providing direct access to the exciton-phonon coupling. We investigate the optical properties of DIP thin films on Si-substrates by variable angle spectroscopic ellipsometry and compare the results with the absorption spectrum of monomers in solution. Since the molecules in the thin film phase are stacked in a highly ordered way the DIP films ($\approx$ 40 nm) exhibit strongly anisotropic optical properties with uniaxial symmetry. Due to this anisotropy, it is necessary to perform a multisample analysis in order to obtain the optical function reliably. This data analysis is discussed for the energy range from 1.25 to 3 eV. A part of the vibronic progression resembles the vibronic subbands of dissolved monomers, but the quantitative interpretation of additional features requires an analysis with a model allowing for the interference between neutral molecular excitations and intermolecular charge transfer transitions.

DS 5.4 Mon 18:30 H 2013

Exciton-phonon coupling in rubrene thin films — •Milan Kytka[1,2], Linus Gisslen[3], Alexander Gerlach[1], Jaroslav Kováč[2], Reinhard Scholz[3], and Frank Schreiber[1] — [1]Institut für Angewandte Physik, Auf der Morgenstelle 10, 72076 Tübingen — [2]Faculty of Electrical Engineering and Information Technology, Slovak University of Technology in Bratislava — [3]Walter Schottky Institut, Technische Universität München

We investigate the absorption spectra of amorphous rubrene thin films (thickness $\sim$30 nm) and rubrene molecules in solution using spectroscopic ellipsometry and UV-VIS spectroscopy, respectively. We evaporated purified rubrene material under UHV conditions and measured the optical constants $n + ik$ in-situ. Both for the solution and the thin films, we find a well-defined vibronic progression of the S_0–S_1 transition of rubrene, because of the small orbital overlap of the π-electrons in the tetracene backbone with the four phenyl groups. We present a detailed data analysis for the progression of the vibronic transitions in the thin film and in the solution. Employing the model of displaced harmonic oscillator we obtain the characteristic parameters of the first absorption band. Using B3LYP/DZ (DFT) calculations we find good agreement with the experimental data. We find that the variation of the electronic and vibrational energy as well as the slightly higher electron-phonon coupling may be assigned not only to intermolecular interactions, but also to a different conformation of the molecule in the thin film phase.

DS 5.5 Mon 18:45 H 2013

Reduced intermolecular interaction in organic ultra-thin films of α-NPD: A multi-sample analysis using VUV ellipsometry — •Sukumar Rudra[1], Cameliu Himcinschi[1], Sindu John Louis[1], Marion Friedrich[1], Christoph Cobet[2], Norbert Esser[2], and Dietrich r.t. Zahn[1] — [1]Technische Universität Chemnitz, Chemnitz, Germany — [2]Institute for Analytical Sciences, Berlin, Germany

In situ ellipsometry using synchrotron radiation in the vacuum ultraviolet (VUV) range was employed to study the growth of α-NPD films starting from submonolayer coverage to bulk-like thicknesses. α-NPD was deposited on hydrogen passivated silicon and on ZnO (either Zn side or O side polished) substrates under ultra-high vacuum condition by organic molecular beam deposition. Ellipsometry was used to study the evolution of the dielectric function of the layers as a function of thickness on H-Si. It was found that the VUV absorption maxima of the ultra-thin film in the submonolayer thickness are spectrally blueshifted compared to its bulk counterparts. To confirm the role of the substrate in the blueshift, it was further studied on two different faces of ZnO substrates and the same behaviour was observed even though the shift was reduced compared to that on H-Si. Reduced intermolecular interaction seems to be the dominant reason behind the shift, whereas the substrate dependence is attributed to the changes in the local field due to the different polarizing media.

DS 5.6 Mon 19:00 H 2013

Improved understanding of polythiophene photo-oxidation mechanism and the role of PMMA layers as diffusion barriers — •Holger Hintz[1], Hans Joachim Egelhaaf[2], Ulf Dettinger[1], Umut Aygül[1], Heiko Peisert[1], and Thomas Chassé[1] — [1]University of Tübingen, Institute for Theoretical and Physical Chemistry, Auf der Morgenstelle 8, D-72076 Tübingen — [2]Christian-Doppler Labor für oberflächenoptische Methoden, Johannes-Kepler University & Konarka Austria GmbH, Altenbergerstaße 69, A-4040 Linz

Polythiophene (P3HT) plays an important role in organic electronic devices. The stability of this material is still unsatisfactory and the degradation mechanism has not yet been fully understood. Investigations of the photo-oxidation of thin P3HT layers were performed under ambient conditions and under varying partial pressures of oxygen and water using Xenon light. The degradation kinetics were investigated using UV/VIS spectroscopy. A linear decrease of absorbance was observed under all experimental conditions. In the presence of water, the oxidation rate increased significantly. The deposition of thin PMMA films on top of the P3HT layers clearly lowered the degradation rate under ambient conditions. In order to understand this stabilizing effect, oxygen diffusion coefficients through the PMMA top layer were determined by monitoring the quenching kinetics of the fluorescence of the P3HT layer. It was attempted to rationalize the experimental results by numerical simulations of the degradation kinetics.