SYOO 2 Optoelectronic Properties

Zeit: Montag 11:30–13:00 Raum: TU C130

SYOO 2.1 Mo 11:30 TU C130

Electronic Spectroscopy of Organic Semiconducters in Helium Nanodroplets — •O. Bünermann, M. Wewer, and F Stienkemeier — Fakultät für Physik, Universität Bielefeld, Universitätsstr. 25, D-33615 Bielefeld

Helium nanodroplet isolation spectroscopy (HENDI) is applied to study organic molecules and nanostructures of molecules. E.g., PTCDA and MePTCDI have been investigated. The suprafluid and cold helium environment allows to characterize geometric as well as electronic structures of these molecules [1]. In particular, charge transfer processes in complexes of molecules can be addressed [2]. By using a new pulsed laser system we were able to extend the measurements to a much wider range of excitation energies. Furthermore the opportunity arises to investigate other interesting molecules. Recent results in this line of work will be presented.

[1] M. Wewer and F. Stienkemeier, J. Chem. Phys. 120(3), 1239 (2004).
[2] M. Wewer and F. Stienkemeier, Phys. Rev. B 67, 125201 (2003).

SYOO 2.2 Mo 11:45 TU C130

A universal picture of chromophores in PI-conjugated polymers: the single molecule approach — •Florian Schindler[1], John M. Lupton[1], Jochen Feldmann[1], and Ullrich Scherf[2] — [1]Photonics and Optoelectronics Group, Department of Physics, LMU Munich — [2]FB Chemie, University of Wuppertal

Single molecule spectroscopy provides unique insight into the fundamental photophysics of electroactive conjugated polymers by overcoming disorder broadening [1]. We apply this technique to the ordered ladder-type poly(para-phenylene) and disordered poly(phenylene-vinylene) (PPV) at low temperatures. We observe identical spectroscopic features on the single chromophore level, such as similar fluorescence linewidths and spectral diffusion dynamics, which appear to be independent of the chemical structure [2]. However, interchromophoric coupling mechanisms differ strongly. In PPV, coherent coupling results in spectral broadening. Such behaviour is absent in ladder-type polymers, where the linewidth of the emissive species is identical for all molecules. By comparing a model ladder-type oligomer with the ladder-type polymer we can also clarify the effective conjugation length of the polymer and count the number of chromophores present on the chain. Our results demonstrate that structure-property relationships in conjugated polymers derive mainly from chain morphology rather than chromophoric properties and should be considered extrinsic in nature.

[1] Müller et al., PRL 91, 267403 (2003)
[2] Schindler et al., PNAS 101, 14695 (2004)

SYOO 2.3 Mo 12:00 TU C130

Work Function Independent Hole Injection Barriers Between Pentacene and Conducting Polymers — •Norbert Koch[1], Andreas Elschner[2], Robert L. Johnson[3], and Jürgen P. Rabe[1] — [1]Humboldt-Universität zu Berlin, Institut f. Physik, Newtonstr. 15, D-12489 Berlin — [2]H. C. Starck GmbH, c/o Bayer AG, D-51368 Leverkusen — [3]Universität Hamburg, Institut f. Experimentalphysik, D-22761 Hamburg

The interface formation between conducting polymers, containing poly(3,4-ethylenedioxythiophene) (PEDT) and sulfonate moieties, and pentacene was studied by ultraviolet photoelectron spectroscopy (UPS) and atomic force microscopy. By employing in situ polymerized PEDT, PEDT with sulfonate moieties on the side chain, and dispersions of PEDT and poly(styrenesulfonic acid), the work function Φ of pristine polymer films could be varied from 4.25 - 5.15 eV. After the deposition of pentacene UPS results show that the hole injection barrier Δ at interfaces between these polymers and pentacene (ca. 0.35 eV) is virtually independent of the initial Φ. This is in marked contrast to interfaces between metals and pentacene, where Δ varies significantly with metal Φ. A chemical reaction between pentacene and PEDT cations is proposed to lead to a pinning of pentacene molecular levels relative to the Fermi-level. These results are of paramount relevance for novel conductive polymers: increasing conductive polymer Φ does not implicitly lead to smaller Δ.

SYOO 2.4 Mo 12:15 TU C130

Kelvin Probe Force Microscopy on Plastic Solar Cells — •Harald Hoppe[1], Thilo Glatzel[2], Michael Niggemann[3], Andreas Hinsch[3], Martha Ch. Lux-Steiner[2], and N. Serdar Sariciftci[1] — [1]Linz Institute for Organic Solar Cells (LIOS), Physical Chemistry, Johannes Kepler University Linz, Altenbergerstr. 69, A-4040 Linz, Austria — [2]Hahn-Meitner Institut, Glienicker Strasse 100, 14109 Berlin, Germany — [3]Fraunhofer Institute for Solar Energy Systems (ISE), Heidenhofstr. 2, D-79110 Freiburg, Germany

A comprehensive Kelvin probe force microscopy (KPFM) study in ultrahigh vacuum (UHV) has been performed on bulk heterojunction solar cells based on MDMO-PPV:PCBM (poly-[2-(3,7-dimethyloctyloxy)-5-methyloxy]-para-phenylene-vinylene: 1-(3-methoxycarbonyl) propyl-1-phenyl [6,6]C61) blends. The KPFM method yields both, topography and local work function at the nanometer scale. Experiments were performed under UHV conditions to extract absolute work function values of the different surfaces and were conducted either in the dark or with cw-laser illumination to get detailed information on the photoactivity of the films. We found considerable differences in the energetics on the surface of chlorobenzene and toluene cast blend films. We were able to interpret the KPFM results together with high resolution scanning electron microscopy (SEM) experiments. The results indicate a morphological hindrance for electron propagation towards the cathode in the case of toluene cast films.

SYOO 2.5 Mo 12:30 TU C130

Widely tunable organic semiconductor lasers for the entire visible spectrum — •Torsten Rabe[1], Daniel Schneider[1], Matthias Hoping[1], Thomas Dobbertin[1], Michael Kröger[1], Thomas Riedl[1], Hans-Hermann Johannes[1], Wolfgang Kowalsky[1], Thomas Weimann[2], Jing Wang[2], and Peter Hinze[2] — [1]Institut fuer Hochfrequenztechnik, Technische Universitaet Braunschweig, 38092 Braunschweig, Germany — [2]Physikalisch-Technische Bundesanstalt Braunschweig, Bundesallee 100, 38116 Braunschweig, Germany

We report on organic semiconductor lasers emitting from the deep red to the near ultra violet using only a few different organic materials as active media. The guest-host system DCMII:Alq_3 is well known for lasing in the red spectral region. We demonstrate an ultra wide tuning range of more than 115 nm by variation of the grating period of a second order distributed feedback (DFB) resonator. Furthermore we introduce various guest-host systems for blue-green DFB-structures. In an all-spiro system (consisting of a Spiro-sexiphenylene compound doped with Spiro-DPVBI (1.1wt%)) we observe first order DFB-lasing with laser thresholds as low as 320 nJ/cm^2 at 478.0 nm. With the pure sexiphenylene compound we obtain laser emission between 401.5 nm and 434.2 nm, using a quaterphenylene derivative even between 377.7 nm and 394.8 nm. The tunability of the neat materials are still 32.7 nm and 17.1 nm, respectively. Hence, using these few materials we are able to cover almost the entire visible spectrum. All these lasers base on thin film DFB-structures and are highly attractive for disposable laser sources for examble in bioanalytical spectroscopy.

SYOO 2.6 Mo 12:45 TU C130

Modelling of modal gain and laser threshold in electrically pumped organic semiconductor optical amplifier and laser diode structures — •Christof Pflumm, Christian Karnutsch, Martina Gerken, and Uli Lemmer — Lichttechnisches Institut, Universität Karlsruhe, Kaiserstraße 12, 76128 Karlsruhe

We present a model to calculate the modal gain in organic optical amplifiers and the threshold power density in organic laser diode structures. The dependence of the modal gain and threshold power density on electron and hole mobility, injection barriers and the thickness of the active layer is investigated. In order to achieve appreciable gain of ≈ 1/cm at a power density of $P = 50$kW/cm^2, equal charge carrier mobilities are of crucial importance. For injection barriers up to $\phi_b = 0.3$ eV, the gain remains nearly constant. If different devices are compared on the basis of equal power density, there is an optimum thickness for the active layer of $d \approx 200$ nm. Power laws for the dependence of modal gain on mobility and power density are derived. These can serve as guidelines for future device design considerations. To quantify the influence of polaron

absorption in optical amplifiers, a figure of merit ζ is introduced. For the most favourable parameters, the polaron absorption cross section has to be at least twenty times smaller than the cross section for stimulated emission in order to achieve net gain. We investigate the dependence of the laser threshold power density on the above mentioned parameters. For the optimum case considered, the power density necessary for lasing in the considered single layer devices is 25 times higher than the highest value reported in the literature to date.