

band gap of  $\sim 2.26$  eV, has been considered as a prospective material for photosensing application. In this work, ZnTe nanowires have been synthesized by Vapor-Liquid-Solid method with optimized growth parameters. They have been incorporated in the well known single nanowire field effect transistor (SNFET) device structure to be electrically characterized in dark and under illumination. The wavelength dependent response of our ZnTe NW based photodetector has been investigated under near IR to near UV illumination.

HL 69.7 Wed 16:00 Poster A

**Analysis of the energy transfer process in ZnS:Mn and ZnS:Tb by a modified Förster model** — ●SEBASTIAN GIES<sup>1</sup>, UWE KAISER<sup>1</sup>, WOLFRAM HEIMBRODT<sup>1</sup>, SEBASTIAN GEBURT<sup>2</sup>, and CARSTEN RONNING<sup>2</sup> — <sup>1</sup>Dept. of Physics, Philipps-University Marburg, Germany — <sup>2</sup>Institute of Solid State Physics, Friedrich-Schiller University Jena, Germany

Zinc Sulphide nanowires doped with different luminescence centers, i.e. Manganese and Terbium, are characterized by means of time-resolved photoluminescence spectroscopy, in order to analyze the energy transfer process quantitatively. To achieve this, a modified Förster model is utilized, describing the energy transfer with respect to migration, quenching processes and dimensionality of the energy transfer.

To test the resilience and validity of the modified Förster model nanowires with doping concentrations from  $4 \cdot 10^{-3}\%$  to 4% were manufactured. The luminescence of the internal  $4f^8$ - ( $Tb^{3+}$ ) and  $3d^5$ -transitions ( $Mn^{2+}$ ) was measured over four orders of magnitude. Furthermore, the measurements were performed at varying excitation densities and temperatures, leading to a deeper understanding of the energy transfer process and its description via the modified Förster model. We were able to determine the hitherto unknown Förster radius of  $Tb^{3+}$  ions. Moreover, using  $\mu$ -photoluminescence we have performed measurements on single nanowires and compared the results with measurements on macroscopic numbers of wires. We found, that the decay characteristics of single wires resemble the ensemble measurements. The statistical reason will be discussed in detail.

HL 69.8 Wed 16:00 Poster A

**Excitons in ZnCdSe/ZnSe quantum dots with parabolic confinement potential** — ●TAMAR TCHELIDZE<sup>1</sup> and IRAKLI NOSELIDZE<sup>2</sup> — <sup>1</sup>Iv. Javakishvili Tbilisi State University, Faculty of Exact and Natural Sciences, 3 Chavchavadze Ave. 0179 Tbilisi, Georgia — <sup>2</sup>Rustaveli National Science Foundation, 1 Aleksidze st. Tbilisi, Georgia

Material distribution profile is found to have significant influence on emission properties of quantum structures. It was reported that core/shell ZnCdSe/ZnSe semiconductor nanocrystals individually exhibit continuous, non-blinking photoluminescence, which was explained by softening the abrupt confinement potential of a typical core/shell nanocrystal, suggesting that the structure is a radially graded alloy of CdZnSe into ZnSe (Xiaoyong Wang et al, Nature 459, 686-689, 2009). We present exact calculation of electronic states for spherical core\*shell quantum dots with realistic boundary condition: inside the dot potential is taken equal to  $-ar^2$ , outside the dot - zero. Calculations are carried out for ZnCdSe/ZnSe structure. We use single band effective mass approximation for finding single particle states of electrons and holes. Exciton states with corresponding energies are calculated by direct diagonalization of Hamilton matrix for 8 lowest excitonic states and their radiative decay probability in dependence of quantum dot radius are calculated. We found that for quantum dots with radius less than 8 nm there is no electron levels inside the dot. For this radius exciton binding energy is 56 meV.

HL 69.9 Wed 16:00 Poster A

**Single crystals by vapor and solution growth of organic semiconductors** — ●JAN-PETER BÄCKER, NATALIJA VAN WELL, and CORNELIUS KRELLNER — Physikalisches Institut, Goethe-Universität Frankfurt, Deutschland

The growth and investigations of single crystals of small molecule organic semiconductors is of crucial importance for the deeper understanding of these materials. We apply both a horizontal vapor-growth technique as well as growth from solutions to fabricate mm-sized single crystals of Phenanthrene, Pentacene, and Dibenzopentacene. In this contribution, we present the optimized crystal growth parameters together with investigations of the structural properties.

Recently, it was found that in some of these materials superconductivity can emerge after intercalation with alkali-earth metals [1]. Therefore, these materials are promising with respect to their semi-

conducting as well as superconducting properties. Here, we show the results of our preliminary intercalation experiments on single crystals to investigate the crossover from semi- to superconducting behaviour.

[1] M. Xue et al., Scientific Reports 2, 389 (2012).

HL 69.10 Wed 16:00 Poster A

**Surface functionalization and optical characterization of self-organized surface structures on sublimation grown polyaromatic single crystals** — ●TERESA SCHMEILER<sup>1</sup>, STEFAN THOMS<sup>1</sup>, and JENS PFLAUM<sup>1,2</sup> — <sup>1</sup>Inst. Exp. Phys. VI, Julius-Maximilians-University of Würzburg, 97074 Würzburg — <sup>2</sup>ZAE Bayern e.V., 97074 Würzburg

Previously we presented different approaches, such as epitaxial growth or surface etching, to generate micrometer-sized 3D pyramidal surface structures on polyaromatic single crystals of rubrene and diphenylanthracene. By means of FDTD-simulations as well as photoluminescence measurements an enhanced luminescence emission at the lateral edges has been observed. Upon further optimization this could lead to cavity structures with defined optical properties. In this context, one of the major drawbacks are reflection losses at the interfaces of these organic structures resulting in a significantly reduced quality factor Q. In this contribution we will discuss a possible solution to this problem by means of an additional metallic, e.g. gold, cover layer. Optical investigation revealed an enhanced emission at the pyramidal cone ends when covered by a 50 nm gold layer. Consequently, the influence of surface functionalization on the cavity quality factor as well as on the population density of optical states was investigated as a function of material and cover layer thickness. Complementary, the coated surface structures were analysed by AFM as well as SEM which showed a homogenous metallic surface coverage. Financial support by the DFG research unit FOR1809 is gratefully acknowledged.

HL 69.11 Wed 16:00 Poster A

**Influence of the presence of residual gases during sample fabrication on the performance and lifetime of OLEDs** — ●FLORIAN WÖLZL<sup>1</sup>, INES RABELO DE MORAES<sup>2</sup>, BJÖRN LÜSSEM<sup>1</sup>, KARL LEO<sup>1</sup>, and MALTE C. GATHER<sup>1</sup> — <sup>1</sup>Institut für Angewandte Photophysik, Technische Universität Dresden, George-Bähr-Str. 1, 01062 Dresden, Germany — <sup>2</sup>Institut für Photonische Technologien Jena Albert-Einstein-Straße 9 07745 Jena

Due to their application potential in lighting and display technology, organic light emitting diodes (OLEDs) have been attracting considerable attention. However, the lifetime of these devices is still a bottleneck for a broad application of the technology. Revealing the degradation processes, especially the chemical degradation is of great interest. In particular the processing conditions, such as the amount of residual gases during the deposition of the materials might have considerable influence. To manipulate their partial pressures during evaporation, a needle valve was added to the processing chamber which can be connected to a nitrogen or oxygen gas bottle as well as to a water-filled gas-washing bottle. This allows us to intentionally contaminate the chamber with these gases. The devices are prepared under a base pressure of  $5 \cdot 10^{-6}$  to  $10^{-8}$  mbar. In this work we will focus separately on the influence of nitrogen oxygen and water during the OLED preparation on the performance and lifetime of a p-i-n OLED based on the stable red triplet emitter tris(1-phenylisoquinoline) iridium(III) ( $Ir(piq)_3$ ). By LDI-TOF-MS technique, the chemical degradation processes of an electrically driven OLED are investigated.

HL 69.12 Wed 16:00 Poster A

**Simulations of electronic states at grain boundaries in polycrystalline naphthalene** — ●MARKO MLADENIĆ, NENAD VUKMIROVIĆ, and IGOR STANKOVIĆ — Scientific Computing Laboratory, Institute of Physics Belgrade, University of Belgrade, Serbia

One of the limiting factors for charge carrier transport in polycrystalline organic semiconductors based on small molecules are grain boundaries. We investigated the electronic structure of grain boundaries in polycrystalline organic semiconductor naphthalene. Energy of the system was modeled using TraPEE potential for the interaction between atoms. Atomic structure was obtained by a Monte Carlo method. Electronic structure was obtained using the Charge patching method (CPM) [1], which is based on Density Functional Theory (DFT).

Results for small systems (1000 molecules) indicate that grain boundaries produce trap energy states within the band gap of the material. These states are localized on molecule pairs (called trapping pairs) at the grain boundaries with the distance between molecules sig-

nificantly smaller than the distance between two adjacent molecules in a naphthalene crystal. Strong correlation between trapping pair mutual distance and trap state energy relative to the top of the valence band energy was found. As a consequence, on the basis of the densities of trapping pairs, densities of trap states for bigger systems (100 000 molecules) were calculated.

[1] N. Vukmirovic, L. Wang, *J. Chem. Phys.* **128**, 121102 (2008)

HL 69.13 Wed 16:00 Poster A

**Polarization-resolved absorption of perfluoropentacene** — ●JAN KUHNERT, KOLJA KOLATA, TOBIAS BREUER, GREGOR WITTE, and SANGAM CHATTERJEE — Philipps-Universität Marburg

Organic semiconductors are promising materials for future electronic applications. A well investigated and prototypical organic semiconductor is the p-type pentacene (PEN). Crystalline PEN films exhibit a pronounced Davydov-splitting of the excitonic excitations owing to the herringbone arrangement of both molecules within the unit cell (adopting an angle of about 52°). Perfluorination yields an n-type semiconductor (perfluoropentacene, PFP) which also exhibits a herringbone packing in the crystalline phase but with almost orthogonal arrangement (91,2°) between both molecules. Using polarization-resolved absorption measurements we demonstrate the presence of a Davydov-splitting in crystalline PFP films that were epitaxially grown on NaF(100) substrates. Moreover, by employing micro-spot illumination single crystalline domains and their azimuthal dependent excitation were analyzed. Measurements were performed at room temperature and at 10K, and yield an energetic splitting of both Davydov components of 27meV. Azimuthal resolved measurements reveal that the transition dipole moment of the high energy component is maximal for polarization parallel to the b-axis; accordingly, the transition dipole of the low energy component is oriented along the c-axis. The experiments demonstrate a Davydov-splitting like behavior despite an almost orthogonal molecular packing in the unit cell where a degeneration of excitonic components is anticipated.

HL 69.14 Wed 16:00 Poster A

**Optical Spectroscopy on planar ZnO/Pentacene Hybrids** — ●INGO G. MEYENBURG, MANUEL DEMPEN, JONATAN HELZEL, MIRA EL HELOU, TOBIAS BREUER, GREGOR WITTE, and WOLFRAM HEIMBRODT — Philipps Universität Marburg department of physics and material sciences centre Germany, Renthof 5, D-35032 Marburg

In recent years organic semiconductors have attracted considerable attention because of their unique optical, electronic and mechanical properties. It has been shown, for example that inorganic organic hybrids like p-type Pentacene on ZnO are feasible to prepare p-n-junction. To study the excitonic properties of the organic layer we prepared pentacene films with thicknesses in the range between 10 nm and 100 nm on different ZnO surfaces by molecular beam deposition under ultra-high vacuum. By varying the growth temperature we obtain pentacene films in an amorphous, in the thin film and the Campbell phase which were characterized by AFM and X-ray diffraction measurements. Due to a formation of crystalline islands in the range of several micrometres in the non-amorphous phases we were able to study the absorption behavior of these single crystals by varying the temperature and the light polarization. In comparison to the pentacene molecules in solution the absorption spectra of the crystalline pentacene exhibit additional pronounced Davydov-splitting excitonic features with characteristic polarization dependence. A detailed discussion will be given of the exciton properties at the organic-inorganic interface in dependence on the crystallographic structure and the orientation of the ZnO surfaces.

HL 69.15 Wed 16:00 Poster A

**Temperature dependent exciton diffusion length in organic solar cells** — ●BERNHARD SIEGMUND, JOHANNES WIDMER, CHRISTIAN KÖRNER, DEBDUTTA RAY, KARL LEH, and MORITZ RIEDE — Institut für Angewandte Photophysik, Dresden, Germany

The photo-current of organic solar cells is the result of a multi-step process from the generation and diffusion of excitons to their separation into free charge carriers being then transported to the electrodes and extracted. In this work, the exciton diffusion length as function of temperature as well as a combined probability for charge carrier recombination and extraction are investigated in devices with a flat heterojunction between ZnPc and C60. To accomplish this, jV-characteristics of organic solar cells and the optical properties of the constituting single layers are studied at different temperatures in the range of 100 to 350K. Furthermore, the thickness of ZnPc is systematically varied

from 7 to 70nm as well as the illumination intensity over two orders of magnitude to verify the obtained values. The results may lead to a better understanding of the temperature behaviour of organic solar cells.

HL 69.16 Wed 16:00 Poster A

**Excitation of surface plasmon polaritons via prism coupling and metallic nanostructures for applications in organic solar cells** — ●MICHAEL MAYR, BJÖRN GALLHEBER, MARK GRUBER, and WOLFGANG BRÜTTING — University of Augsburg, Germany

Organic photovoltaic cells based on diindenoperylene (DIP) exhibit high crystallinity in thin films resulting in long-range exciton transport and high charge carrier mobilities<sup>1,2</sup>. Due to nearly perpendicular orientation of the transition dipole moment with respect to the substrate, however, DIP exhibits only weak absorption for direct illumination, but tends to couple strongly to the near-field of surface plasmon polaritons (SPPs). Moreover, DIP provides a low lying HOMO and LUMO, which results in high open circuit voltages when using it as acceptor in combination with commonly used donor materials like oligo- or polythiophenes<sup>3</sup>. This makes DIP a promising candidate for using SPPs to increase the efficiency of organic solar cells. Due to the need for conservation of momentum and energy, light induced far-field excitation of SPPs at metal/dielectric medium interfaces is impossible. We use glass prisms and metallic nanostructures made by nanosphere lithography to overcome this problem, as they can manipulate the in-plane wave vector of incident photons to fulfill this condition. Particularly metallic nanostructures permit tuning of the excited SPPs by adjusting the size of the used nanospheres.

<sup>1</sup> J. Wagner et al. *Adv. Func. Mater.* **20**, 4295 (2010).

<sup>2</sup> D. Kurrle et al. *Appl. Phys. Lett.* **92**, 133306 (2008).

<sup>3</sup> U. Hörmann et al. *phys. stat. sol. RRL* **5**, 241 (2011).

HL 69.17 Wed 16:00 Poster A

**Loss mechanisms in organic bulk heterojunction solar cells investigated by differential photocurrent density measurements** — ●PHILIPP PELCHMANN<sup>1</sup>, SIMON HEIN<sup>1</sup>, ANDREAS ZUSAN<sup>1</sup>, VLADIMIR DYAKONOV<sup>1,2</sup>, and CARSTEN DEIBEL<sup>1</sup> — <sup>1</sup>Experimental Physics VI, Julius-Maximilians-University of Würzburg, D-97074 Würzburg — <sup>2</sup>Bavarian Centre for Applied Energy Research (ZAE Bayern e.V.), D-97074 Würzburg

Organic solar cells are interesting for contributing to the solution of the growing demand for renewable energy sources. One of the main problems is their lower efficiency compared to their inorganic counterparts. For its optimization, a fundamental understanding of the loss mechanisms, i.e. geminate and non-geminate recombination, is crucial. The non-geminate recombination, a function of light intensity under short-circuit conditions, can be investigated by differential photocurrent (DPC) measurements [1]. Therefor, the electrical response of a solar cell to a superposition of a continuous background light and a modulated low intensity light is determined. We measured the DPC signal for bulk heterojunction solar cells made from poly(3-hexylthiophene) (P3HT) blend with [6,6]-phenyl C61-butyric acid methyl ester (PCBM) with various active layer thicknesses. The results are discussed with regard to non-geminate recombination of free and trapped charge carriers.

[1] L. J. A. Koster et al., *Adv. Mater.*, **23**, 1670 (2011)

HL 69.18 Wed 16:00 Poster A

**Hybrid Organic Photodetectors for Radiography** — ●PATRIC BÜCHELE<sup>1,2</sup>, OLIVER SCHMIDT<sup>2</sup>, SANDRO TEDDE<sup>2</sup>, DAVID HARTMANN<sup>2</sup>, MOSES RICHTER<sup>3</sup>, and ULI LEMMER<sup>1</sup> — <sup>1</sup>Light Technology Institute, Karlsruhe Institute of Technology, Karlsruhe, Germany — <sup>2</sup>Siemens AG, Corporate Technologies, Erlangen, Germany — <sup>3</sup>Institute for Materials for Electronics and Energy Technology, Friedrich-Alexander University, Erlangen, Germany

Most of today's x-ray detectors are using an indirect conversion mechanism. The x-ray radiation is converted into visible light within a thick scintillator layer. The visible light is then absorbed by standard thin-film photodetectors. The isotropic propagation of light in the scintillator reduces the resolution of the x-ray imager. This work avoids the stacked structure by integration of inorganic PbS quantum dots directly into the bulk heterojunction (BHJ) of an organic photodetector. X-ray photons are immediately converted into charge carriers and travel in direction of the electrical field towards the electrodes. However, this concept demands much thicker organic layers than known from conventional OLED and OPV processing. We demonstrate that thick diodes can be achieved with a spray coating process and the