SYOO 3 Organic Optoelectronics and Photonics I

Zeit: Montag 14:00–16:15 Raum: TU HE101

Hauptvortrag SYOO 3.1 Mo 14:00 TU HE101

Excited states at heterojunctions between polymeric semiconductors — •Richard H. Friend — Cavendish Laboratory, Madingley Road, Cambridge, CB3 0HE, UK

Much of the important device physics of molecular or polymeric semiconductor structures is controlled by heterojunctions between different semiconductors. Band-edge offsets at these heterojunctions can be engineered through the selection of the two semiconductors, and are generally chosen to provide type II heterojunctions.

For operation in photovoltaic mode, a diode requires a heterojunction with band-edge offsets larger than the exciton binding energy (typically 0.5 eV), so that an exciton present at the heterojunction will be ionisated across the heterojunction. For operation as a light-emitting diode, the band-edge offsets must then be set so that the bound exciton is stable against charge separation.

Close to the threshold for exciton ionisation at the heterojunction, we find that the intrachain exciton can be localised at the heterojunction, by acquiring some degree of charge-transfer character, though still retaining a substantial binding energy. With respect to the bulk exciton, the exciplex is red-shifted and its radiative lifetime is strongly increased. The barrier for thermal excitation of the exciplex to allow it to move away from the heterojunction can be chosen to be small, so that this process can give efficient bulk exciton emission at room temperature, and efficient operation of LEDs.

Hauptvortrag SYOO 3.2 Mo 14:45 TU HE101

Organic Semiconductors: New Materials, Physics and Devices for Modern Optoelectronics — •Stephen Forrest — Princeton Institute for the Science and Technology of Materials (PRISM), Department of Electrical Engineering, Princeton University, Princeton, NJ USA

Although research on the physics and chemistry of organic semiconductors has been vigorously pursued for over half a century, the exploitation of this vast range of materials remains in its infancy. Indeed, due to the weak coupling between molecules within a thin film composed of small molecular weight or polymeric materials, the fundamental processes of charge transport and light generation are not as well understood as their highly ordered, inorganic semiconductor counterparts. In this respect, gaining a full understanding of such soft materials remains a significant challenge in the field of condensed matter physics. Nevertheless, already we are seeing applications of organics enter the commercial sphere; most notably in organic emissive displays and thin film transistor circuits for product identification. In this presentation, I will review some of the important and unique properties of organic materials for electronic applications, focusing on film growth modes, and electronic and optical processes that are closely linked to both film and molecular structure. Furthermore, I will discuss several important device demonstrations based on the very high performance of organic semiconductors as they are applied to organic light emitting devices, thin film transistors, and photovoltaic cells.

Hauptvortrag SYOO 3.3 Mo 15:30 TU HE101

Organic Single-crystal Field-Effect Transistors — •Alberto Morpurgo — Kavli Institute of Nanoscience, Delft University, Netherlands

During the past two years different research groups have succeeded in fabricating field effect transistors (FETs) on organic single crystals of many different molecules. The unprecedented purity and reproducibility of these devices is enabling now the study of the intrinsic electronic transport properties of organic semiconductors as a function of charge density. In addition, beside the fundamental questions, the high device reproducibility enables to address technologically relevant issues related to elemental aspects of the devices and their influence on the device performance. After an explanation of the technological progress that has made this work possible, I will present an overview of the results that have been obtained so far. These include: 1) the achievement of unprecedented values of mobility (30 cm^2/Vs), 2) the observation of anisotropic transport characteristics as a function of the crystal orientation, 3) a metallic-like temperature dependence of the mobility, 4) the first direct demonstration of the polaronic nature of charge carriers in organic semiconductors, and 5) the successful operation of organic single crystal FETs in the high density regime, where the effect of Coulomb interaction cannot be neglected. I will conclude by summarizing the present status of this research area and by illustrating prospects for upcoming work.