CPP 22: Organic Electronics and Photovoltaics II

Time: Tuesday 14:00–15:15 Location: H38

CPP 22.1 Tue 14:00 H38

Spontaneous orientation polarization in mixed films of organic semiconductors — •Albin Cakaj, Alexander Hofmann, and Wolfgang Brütting — Experimental Physics IV, Institute of Physics; University of Augsburg, 86135 Augsburg, Germany

Small organic molecules processed by physical vapor deposition (PVD) can exhibit a preferential alignment, despite their tendency to form glassy amorphous films. This alignment can additionally lead to a macroscopic polarization of the film, if the molecules have a permanent dipole moment (PDM). The additional field, also referred to as giant surface potential (GSP), can impact the properties of organic light emitting diodes (OLEDs) significantly. Therefore, understanding the formation and control of this effect is of crucial importance.

We investigated different GSP forming polar molecules mixed with non-polar organic compounds. We found combinations with enhanced PDM alignment, where the impact of suppressed dipole-dipole interactions by dilution is far more significant than the effect on the film-formation process by a change in the effective glass temperature of the blend. Additionally, our data hint to the conclusion that molecules with an already high degree of PDM alignment keep their magnitude of alignment in mixed films without significant enhancement. Therefore, we can conclude that mixing of polar molecules with a non-polar compound can enhance the degree of PDM alignment significantly, if the polar molecules exhibit only a small degree of PDM alignment in the first place.

CPP 22.2 Tue 14:15 H38

Ultrafast Response in Unbalanced Mobility Organic Photodetectors — •Felix Hergenhan, Tianyi Zhang, Karl Leo, and Johannes Benduhn — Dresden Integrated Center for Applied Physics and Photonic Materials (IAPP) and Institute of Applied Physics, TU Dresden, Dresden, 01187 Germany

Organic photodetectors (OPDs) have attracted growing interest due to their potential in various optoelectronic applications. However, the slower response speed of OPDs compared to their inorganic counterparts, primarily influenced by low charge carrier mobilities, has hindered their application in high-speed technologies. In this presentation, we will discuss the dynamic behavior of OPDs, focusing on how ultrafast response times can still be achieved despite significant mobility imbalance and overall low mobility. Importantly, the role of RC (resistance-capacitance) limitations is emphasized, as they significantly impact the achievable response speed of the devices. We systematically investigated the effects of device design, device dimensions, light intensity, and applied bias on OPD performance and its dynamic behavior. Notably, special features could be identified in their dynamic response that led to improved rise and fall times of only a few nanoseconds and a cutoff frequency beyond 10 MHz. We propose a model explaining the origin of these features and demonstrate how to utilize them to achieve faster response times. By exploring the entire picture of device design, material choice, and operational conditions, we provide an outlook on the future development of ultrafast OPDs.

CPP 22.3 Tue 14:30 H38

Systematic variation of acceptor and donor moieties in donor-accerptor-donor small molecules for efficient room-temperature phosphorescence — •Uliana Tsiko, Sebastian Kaiser, Sebastian Schellhammer, and Sebastian Reineke — Dresden Integrated Center for Applied Physics and Photonic Materials (IAPP) and Institute for Applied Physics, Technische Universität Dresden

Room-temperature phosphorescence (RTP) from purely organic materials promises unique application in diverse fields including molecular sensing, bioimaging, information storage, and anti-counterfeiting. With the design of programmable luminescent tags (PLTs), we recently reported a novel photonic device architecture that is well suited for various labelling and information exchange applications and even allows a biodegradable design. However, improved RTP emitters are required to fully exploit this technology.

In our contribution, we systematically analyze the impact of the acceptor and donor moieties on the photophysical properties of newly synthesized RTP emitters to gain an understanding of structure-property relationships. While the electron-accepting character does not significantly affect the emission properties, the electron-donating ability of the donor unit can strongly improve RTP emission, leading to pronounced sky-blue phosphorescence in purely organic materials, which has been rarely observed before. These emitters are further characterized in PLTs as a prototypical excitonic application scenario.

CPP 22.4 Tue 14:45 H38

Efficient room-temperature phosphorescence in small-molecule hosts for applications in information storage — •Yana Bui Thi, Sebastian Schellhammer, and Sebastian Reineke — Dresden Integrated Center for Applied Physics and Photonic Materials (IAPP) and Institute for Applied Physics, Technische Universität Dresden

Room-temperature phosphorescence (RTP) from organic materials promises unique applications in molecular sensing, bioimaging, and information storage. Typically, RTP is achieved by embedding emitter molecules in a rigid matrix to suppress non-radiative decay. The integration of such emitters into polymer hosts has enabled advancements in photonic technologies, such as programmable luminescent tags. However, a comprehensive understanding of host-guest interactions, particularly with small-molecule hosts suitable for vacuum processing, is widely missing. This work investigates the photophysical properties of RTP emitters embedded in wide bandgap small molecules, typically used in OLEDs. Thin films are fabricated either by spin coating or thermal evaporation, the latter offering superior film quality and compatibility with patterning techniques. RTP can be promoted or impaired depending on the choice of the host material, partially even allowing for RTP in the presence of oxygen. A significant enhancement of photoluminescence can be obtained due to favorable energy transfer from host to emitter. These results highlight the importance of the host selection in optimizing emitter performance and present valuable insights for polymer-free RTP-based photonic devices.

CPP 22.5 Tue 15:00 H38

Regulated Growth of Benzoperylene-TCNQ Charge-Transfer Complex Crystalline Networks — •Kirill Gubanov, Yana Reva, Stevie Furxhiu, Fabian Streller, Yifan Bo, Phillip Greissel, Dirk M. Guldi, and Rainer H. Fink — Department of Chemistry and Pharmacy, Friedrich-Alexander-Universität Erlangen Nürnberg, Egerlandstraße 3, 91058 Erlangen, Germany

Highly ordered luminescent organic micro- and nano-crystals of charge-transfer complexes (CTC) are generating a considerable interest due to their prospective applications in miniaturized and multifunctional optoelectronics. We propose a strategy of controlled crystallization growth of Benzoperylene (BP)-TCNQ-CTC nanorods network. As a result of the distinct polarity-based solubility of BP and TCNQ, 2D microsheets of BP of tunable sizes can be used as templates for the CTC nanorod meshes growth in solution. The optical and electronic properties of the respective CTC were additionally investigated. Emission spectroscopy revealed a significant quenching of the BP strong fluorescence upon CTC formation: electron excitation in BP leads to a charge transfer to a non-emissive TCNQ and to non-radiative relaxation. Using NEXAFS micro-spectroscopy, we examined the electronic structure and a temperature-dependent band gap modification. Thus, collective insights into the BP-TCNQ CTC properties provide valuable information for material optimization for future applications in optoelectronic devices. The research is funded by the BMBF (contract 05K19WE2) and SolTech initiative.