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Molecular orientation as key parameter in organic optoelectronics

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Three decades after the first publications on efficient light-emitting diodes and solar cells, organic optoelectronics has become part of our everyday life, e.g. as displays for smartphones or television screens. Furthermore, owing to their unique features, like low-cost large-area processing or the compatibility with various kinds of substrates in almost arbitrary shape, organic semiconductors can lead to new kinds of applications. One of the remarkable differences to their inorganic counterparts is that the majority of molecular semiconductors exhibit orientational degrees of freedom due their anisotropic shape. The microscopic orientation of molecules in thin films has strong impact on macroscopic properties such as charge carrier transport and optical properties as well as on the efficiency of optoelectronic devices.

This talk will discuss the driving forces for molecular orientation in neat films and guest-host systems and give examples for the influence of molecular orientation on optoelectronic properties in different types of structures and the consequences for device functioning. In the first place, the orientation of the optical transition dipole moments of emitter molecules in organic light-emitting diodes controls the light outcoupling efficiency of these devices [1]. As second example, we discuss interfacial polarization caused by partial alignment of the permanent dipole moments of polar molecules. However, while interfacial polarization is well investigated in neat materials, there is a lack of studies evaluating the behavior of two-component mixed systems. Hence, we have investigated guest-host systems with varying concentrations of a polar species in a non-polar matrix. Using dipolar doping we could, on the one hand, achieve a better understanding of molecular interactions leading to a net orientation of the permanent dipole moments [2]. On the other hand, we have utilized this approach to pinpoint molecular orientation of Iridium emitter complexes [3].

[1] T. D. Schmidt, T. Lampe, D. Sylvinson, M. R., Peter I. Djurovich, M. E. Thompson, W. Brütting, Physical Review Applied 8 (2017) 037001.
[2] L. Jäger, T. D. Schmidt, W. Brütting, AIP Advances 6 (2016) 095220.
[3] T. Morgenstern, M. Schmid, A. Hofmann, M. Bierling, L. Jäger, W. Brütting, ACS Appl. Mater. Interfaces, DOI: 10.1021/acsami.8b08963 (August 23, 2018)

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