Organic semiconductors - molecular design considerations

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The properties of organic semiconductors depend critically on the precise arrangement of chromophores in the solid state. In the most highly ordered cases - organic single crystals - intermolecular shifts of only a few picometers can render a high-performance semiconductor useless. Using a simple functionalization scheme, we have developed a reproducible method for tuning the solid-state order of aromatic semiconductors. While simple steric bulk / crystal packing relationships have yielded a general prediction of crystal packing, a finer degree of structural understanding is required to tune solid-state order to optimize performance in applications such as thin-film transistors. We have begun to investigate weak interactions between specific atom types that subtly modify solid-state order, such as Ar-H - - - F type hydrogen-bonding, leading to subtle changes in solid-state configurations. In this lecture, I will present our latest efforts in modifying our crystal packing scheme, describe how the resulting changes in crystal packing impact film morphology and device performance, and describe the application of the resulting design rules to new chromophore types.

Light-matter interaction in planar plasmonic and metamaterial systems: Equilibrium and non-equilibrium effects

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Certain plasmonic and derived systems such as hyperbolic metamaterials promise large and broadband enhancements of the photonic density of states which, in turn, lead to corresponding enhancements of light-matter interaction. In this talk, recent theoretical advances regarding the most simple settings, i.e., planar materials and one- and zero-photon effects (spontaneous emission, Casimir-Polder force, and quantum friction) will be discussed with an emphasis regarding the appropriateness of different material models and the validity of certain approximation schemes such as the Markov and the local thermal equilibrium approximation.