

Molecular Mesoscopics: Approaching Organic Semiconductors from the Bottom Up

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Single-molecule spectroscopy offers the promise of bottom-up understanding of electronic materials. In the field of organic electronics, high-resolution techniques should help identify fundamental limitations to materials performance such as breakdown characteristics, in turn providing synthesis with tools for iterative improvement. Yet while single-molecule characteristics of pi-electron systems are increasingly well understood, models describing the characteristics of bulk devices tend to be phenomenological in nature, building predominantly on concepts derived from continuum systems such as bulk semiconductor crystals.

Bridging the gap between the single molecule and the bulk device requires an excursion into the realm of mesoscopic objects, increasingly large custom-made molecular complexes which mimic the elementary intra- and intermolecular interactions found in devices. Large polymer chains have already tested the limits of the concept of molecules as discrete entities, but are constrained in their utility for deriving robust models due to heterogeneity in molecular shape. In contrast, custom-designed macrocycles combine versatility in the dimensions of the pi-system with precise knowledge of molecular shape. This combined synthetic-spectroscopic approach enables insights into the formation of localised chromophores by spontaneous symmetry breaking, and the emergence of interactions between chromophores on mesoscopic length scales.

Electronic coupling in ZnO-based HIOS

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To achieve HIOS with advanced opto-electronic function, efficient transfer of excitons or charges across the inorganic-organic heterointerface is required. This talk focuses on hybrid systems composed of ZnO-based quantum structures and ladder-type quaterphenylenes (L4Ps). These molecules are custom-made to facilitate efficient excitonic coupling [1], i.e. they feature 0-0 transition energies matching that of the ZnO exciton, spectrally narrow transitions and large transition dipole moments. Selective chemical modifications of L4P allow for fine-tuning of its optical and film-forming properties. The talk discusses resonant energy transfer, addresses the underlying mechanisms and identifies loss channels which must be suppressed in order to achieve hybrid structures with truly superior function.

[1] Kobin, B.; Grubert, L.; Blumstengel, S.; Henneberger, F.; Hecht, S., Vacuum-processable ladder-type oligophenylenes for organic-inorganic hybrid structures: synthesis, optical and electrochemical properties upon increasing planarization as well as thin film growth. *J. Mater. Chem.* 2012, 22, 4383-4390.