New Opportunities for Active Organic Materials

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Man-made organic materials allow to tailor functional device properties in an unprecedented manner. A prerequisite is the fundamental understanding of the underlying physics. In this seminar, I will introduce some of our recent work, in which we investigate the fundamentals of charge motion in carbon-based molecular materials and use the gained insights to develop novel electronic functionality. Examples will include ongoing work on organic solar cells, where I will show how far-from-equilibrium phenomena can be used to make major improvements to device characteristics, including power conversion efficiency. Another research direction that I will touch upon are hybrid semiconducting-dipolar materials that show a strong coupling between ferroelectric polarization and conductivity, that might find application in conventional or neuromorphic memories. The figure shows the design principle of this type of material: a planar molecule with a pi-conjugated core (here a simple benzene ring) and dipolar moieties (here amides) forms helical stacks that are stabilized through hydrogen bonding. The hexagonal packing of multiple stacks in a thin-film geometry results in a material with a bistable electrical polarization that can be flipped by an external electric field. Charge transport along and against the polarization are not equivalent, leading to resistance differences.