Frontiers in nanoplasmonics: from fundamental nanocavity design to applications in sensing, solar light harvesting, and nonlinear nano-optics

Prof. Dr. Stefan Maier,

Centre for Plasmonics & Metamaterials, Imperial College, London

Nanoplasmonics allows the confinement of light on length scales far below the wavelength. This talk will describe some of the current fundamental frontiers of the field, such as nonlocal effects on nanometre length scales and transformation optics design of broadband light harvesting nanostructures. The second part will focus on applications in nonlinear light generation with high efficiency, multi-spectral biosensing, and photovoltaics.model of a plasma in confined geometry one is able to capture nonlocal and nonlinear effects.

ORGANIC AND HYBRID PHOTOVOLTAICS: INTERFACE MATTERS

Dieter Neher

University of Potsdam, Institute of Physics and Astronomy, Potsdam

In past years, the power conversion efficiency of organic and hybrid solar cells has been steadily increasing. These devices have in common that they consist of an electron-donating and an electron-accepting component, which share a common all-organic or hybrid interface.

There is an on-going debate on whether the photovoltaic properties of these cells are determined by the morphology and energetics of this interface or by the properties of the individual electron-donating and –accepting components. Answering this question is rather challenging, as photogeneration in these devices is a multi-step process, comprising excitons generation and diffusion, exciton dissociation into interfacial charge transfer states (CTs), and CT split-up into free charges (charge-separated state, CS)

We have recently established techniques to quantify the amount of extractable charges for a wide range of parameters, e.g. the excitation energy and fluence or the internal electric field. We identified the fully relaxed charge transfer state (CT_0) to be the precursor to free charges in a wide variety of organic donor-acceptor couples of different nature, exhibiting a range of efficiency and energy offsets. Our results disprove conclusions from recent ultrafast transient spectroscopy studies that non-relaxed 'hot' CT states must be involved in efficient photogeneration of charges. We also show that the difference in energy between the relaxed singlet exciton and the CS, often denoted as build-in driving force, does not govern device performance. Thus, the field-dependence and efficiency of free carrier formation is dictated by the location of the CT_0 state energy with respect to the energy of the spatially-separated charge pair. Therefore, materials design should shift from focusing on the lengthscale of the chemical structure of the molecules to that of the microstructure of the film. Indeed, highest efficiencies are obtained by controlling the pathways from the relaxed CT state to the fully charge separated (CS) state, which are dictated by the mesoscopic interfacial morphology.