

Organic Functionalization of Semiconductor Surfaces

Stacey F. Bent

Department of Chemical Engineering, Stanford University, Stanford, CA 94305 USA

Because the surfaces of small structures can dominate their properties, implementing functional nanoscale materials depends to a large extent upon understanding and controlling the surface reactivity. This talk will focus on studies of the adsorption of organic molecules at semiconductor surfaces, toward the ultimate goal of controlling the chemical and electrical properties of these hybrid systems. The presentation will begin by examining model systems of molecular adsorption on the Ge(100)-2×1 surface. Using a combination of experimental (infrared spectroscopy, X-ray photoelectron spectroscopy) and theoretical (density functional theory calculation, Monte Carlo simulation) methods, we will show how the molecular structure as well as the identity of the reactive moieties can affect the product distribution upon adsorption. The reactivity of different functional groups will be described, with particular focus on reactions of bifunctional molecules. The talk will then introduce layer-by-layer organic functionalization using bifunctional molecules as a method to change surface properties. Results in which this multilayer attachment chemistry is extended into a molecular layer deposition (MLD) process for new materials applications will be presented.

Theory of hybrid excitations: coupled plasmons, excitons and photons

Marten Richter

Institute of Theoretical Physics, Technische Universität Berlin, Germany

In this talk, we discuss two types of optical hybrid excitations: (i) quantum emitters (quantum dots / molecules) coupled to plasmons (optical cavities / metals) and (ii) carriers in semiconductor quantum films coupled to excitons in organic molecules.

For (i) we discuss the radiative lifetime of a colloidal quantum dot on silver surfaces with different morphology. A survey of exact methods for the treatment of the coupling of identical quantum few level emitter to photonic excitations is given. In particular, we show that external pumping strength can control the excitation energy distribution between excitons and photon modes.

For (ii) the excitation transfer from a semiconductor electron-hole plasma (e.g. created by electrical injection) to organic molecules is discussed. We show that the alignment of molecules on the semiconductor substrate influences the excitation transfer rates between the constituents. Also, future perspectives for the description of the transfer between disordered semiconductor quantum well excitons and molecules adsorbates are given.