The Alabama Collaborative for Materials Exploration (ACME)

Research Seminar Series

Professor Todd Krauss

Department of Chemistry
University of Rochester

Tuesday, February 25th, 2022
10:00 AM CST
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Polaritons Generated from Strong Coupling between CdSe Nanoplatelets and a Dielectric Optical Cavity

Semiconductor nanoplatelets (NPLs) are colloidal nanoparticles with dimensions on the order of tens of nanometers in the transverse directions, but with an extremely well-defined thickness. As such, compared to their spherical cousins colloidal quantum dots, NPLs have significantly narrower absorption and fluorescence line widths and exceptionally large oscillator strengths. These particular photophysical properties of NPLs make them attractive candidates for achieving strong light-matter coupling. We will discuss the photophysical properties of CdSe NPL exciton polaritons in a distributed Bragg reflector (DBR) cavity. The molecule-cavity hybrid system is in the strong coupling regime with an 83 meV Rabi splitting, characterized from angle resolved reflectance and photoluminescence measurements. Mixed quantum-classical dynamics simulations are used to understand the polariton photophysics of the hybrid system whereby the electronic and photonic degrees of freedom (DOF) were treated quantum mechanically and the nuclear phononic DOF classically. Numerical simulations agree extremely well with the experimental data, providing a fundamental explanation of the asymmetric intensity distribution of photoluminescence from the upper and lower polariton branches. We will also discuss theoretical investigations of polariton-mediated electron transfer reactions in a model nanoparticle-cavity coupled system. For such a system, photoinduced charge transfer reactions between a bright donor state and dark acceptor state can be significantly enhanced, or suppressed, depending on the particulars of the coupling between the molecular system and the quantized radiation field inside the optical cavity. Altogether, these discoveries prove the feasibility of using polaritons derived from NPLs as a new platform for investigating cavity-mediated physical and chemical processes.

Biography: Todd D. Krauss, PhD is a Professor of Chemistry and Optics at the University of Rochester and currently serves as the Chair of Chemistry. Krauss received his BS (1991), MS (1994), and PhD (1998) in Applied and Engineering Physics all from Cornell University, and served as a postdoctoral research fellow at Columbia University in Chemistry from 1998-2000. In 2000 Krauss joined the Chemistry faculty at the University of Rochester as an Assistant Professor. In 2006 he was promoted to the rank of Associate Professor and in 2008 he received a joint appointment in the Institute of Optics. In 2010 Krauss was promoted to full Professor, and assumed directorship of the Rochester Advanced Materials Program (formerly the Materials Science graduate program) for three years. Krauss became Chair of the Department of Chemistry in 2013. Krauss Chaired the Center for Energy and the Environment Structure subcommittee in 2014-2015. Krauss's research interests involve fundamental studies of materials at the nanometer scale down to single molecule level, with specific emphasis on colloidal semiconductor nanoparticles such as semiconductor nanocrystals or carbon nanotubes.

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