Stevens Institute of Technology

Nanotechnology Graduate Program

Controlling light-matter interaction at the nanoscale: novel nanophotonic devices

Wednesday, November 1, 2006
Babbio Bldg, Room 104, Time 11am

Professor Stefan Strauf
Department of Physics & Engineering Physics
Stevens Institute of Technology

Semiconductor nanostructures with embedded quantum dots (QDs) are attractive systems for fundamental studies of light-matter interaction and hold great promise for novel nanophotonic device applications in quantum information science. With the recent progress in nanofabrication technology, it is now possible to control light extremely efficient at the level of individual photons. In this talk, I will discuss two different device concepts and show experimental results of quantum optical measurements demonstrating their outstanding performance.

The first device is an ultra-bright single photon source which is of interest for applications in quantum cryptography. It is based on an oxide-tapered AlGaAs/GaAs micropillar cavity with embedded InAs QDs providing optical quality factors up to 50,000. Buried electrical gates allow a controlled charging of QDs with individual electrons. This suppresses unwanted exciton dark-state configurations and makes light extraction in these devices extremely efficient. Measured rates of single photons on command are as high as 90 MHz, i.e. about 400 times higher than any other single photon source.

The second device is a photonic crystal nanocavity laser. Photonic crystals are of interest due to their unprecedented ability to control, bend, trap, switch, slow, and extract light. It will be shown that very few (2 to 4) QDs as a gain medium are sufficient to realize single-mode photonic-crystal lasers with lasing thresholds of only a few nW. Remarkably, the strong inhibition of spontaneous emission leads to a relaxation of the exciton-mode resonance condition implying a "self-tuning" effect of the QD gain material.

Stefan Strauf joined the Dept. of Physics and Engineering Physics at Stevens in the Fall of 2006 as an Assistant Professor. His research interests are in experimental semiconductor nanophotonics, light-matter interactions in photonic band gap structures, and non-classical light sources for quantum information science. He received his PhD degree in 2001 form the University of Bremen, Germany with a thesis entitled “Impurity luminescence of wide band gap semiconductors”. After a year as a Postdoc at the University of Bremen, Stefan Strauf joined Dirk Bouwmeester’s group at UC Santa Barbara in 2003 as a Research Associate, where he worked on photonic crystal quantum dot lasers, cavity-QED with single quantum dots in micropillar and photonic crystal cavities, and coupled quantum dots.

STEVENS Institute of Technology

Co-sponsored by the Department of Physics and Engineering Physics (PEP)