

Active control of light at the nanoscale using nanowires and nanoantennas

Control over the flow of light at the nanometer length scale using solid-state building blocks is of interest for many technological applications, such as solar cells, integrated optical circuits, and quantum information technology. I will present here our recent results on the ultrafast interactions of light with devices consisting of building blocks like plasmonic antennas or semiconductor nanowires.

Plasmonic nanoantennas have taken hold as an exciting new paradigm in near-field optics. In analogy with their radiowave counterparts, nanoantennas turn out to be an ideal instrument for improving the coupling between far-field light and nanoscale light sources. We have fabricated single antennas and have demonstrated strong enhancement of the radiative efficiency of dye molecules by coupling to the antenna resonances. The enhancement was shown to depend both on the spectral mode structure and on the size of the nanoscale antenna gap.

Next to these relatively simple nanosystems, the complex multiple scattering of light in nanomaterials provides with a rich variety of fundamental phenomena with potential applications ranging from random lasers to solar cells. Using bottom-up growth of semiconductor nanowires we have achieved some of the most strongly scattering materials available today. We are currently investigating how the combination of optical nonlinearity and light scattering in these nanowire layers gives rise to large modulation of their transmission eigenstates.