TRR 142
Tailored Nonlinear Photonics

TRR Guest Scientist Lecture / Seminar

Date/Time: 07.07.2016 / 2pm
Location: TU-Dortmund / P1-02-111

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Light-matter Interaction in Sub-wavelength Nano-photonic Structures

Abstract:

The field of plasmonics not only provides a solution for making compact optical devices, but also addresses the fundamental issue of light-matter interaction. Optical radiation originates from electronic transitions between quantized energy states in materials, but the characteristic length scale of electrons is typically much smaller than the wavelength of light. This size mismatch causes most interactions between light and matter to be weak. Optical components that operate at sub-wavelength regime provides a method to shrink the optical fields and thereby enhancing optical interaction. So far, miniaturization in optics has led to the development of novel light sources such as low-threshold lasers and single photon sources, improvement in optoelectronic devices, and molecular sensing. Another aspect of miniaturization is planarization of integrated optical components which offers increased functionalities and information processing capability. In particular, the use of broadband waveguides which interacts strongly with individual optical emitters provide a promising platform for quantum information processing where an emitter in such a system serves as a processing node that maps its quantum state into a photon that transmits along the waveguides and carries information from one node to another in the network. The research presented in this talk involves the design of photonic components towards that capability.

In this talk, I will describe the use of deep sub-wavelength (sub-λ) nano-photonic structures to enhance radiation of optical emitters. The deep sub-wavelength designs are based on high permittivity contrast of materials involving either purely dielectric interfaces or metal. The building blocks of these nano-photonic system are non-resonant, broadband waveguides with dramatic field confinement in the nano-scale low permittivity region. Strong interaction and enhanced radiation leads to efficient coupling into the primary optical mode of the structures which improves fluorescence brightness, saturation, speed, emission efficiency, single photon fidelity at a single emitter-single photon level and holds promise for solid-state lighting, molecular sensing, and quantum information processing application.

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