TRR 142
Tailored Nonlinear Photonics

TRR Guest Scientist Lecture / Seminar

Date: Wednesday, June 10th
4pm
Location: Paderborn, A1

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Semiconductor nanowire heterostructures: from materials to advanced devices

Abstract

Semiconductor nanowires (NW) comprise a class of low-dimensional nanostructures with very high aspect ratio, offering many interesting features in material design, novel fundamental properties and advanced device applications, particularly in nanoelectronics and nanophotonics. Essentially, their unique one-dimensional (1D) geometry presents an ideal structure to combine various different highly lattice-mismatched semiconductor materials at the nanoscale without forming extended defects, allowing integration of high-performance III-V NWs even on mainstream silicon (Si) platform.

The objective of this seminar lecture is to give insights into the growth and fabrication of III-V-based NWs on Si, their fundamental structural, electronic and size quantization properties, and exploitation of these to realize high-performance NW-based electronic switches and coherent emitters such as NW lasers. A distinct feature of these III-V based NWs is their large sensitivity to detrimental surface states that often govern their electronic and optical properties due to the increased surface-to-volume ratio. Hence, passivating core-shell NW heterostructures are essential as these inhibit surface scattering of charge carriers, suppress non-radiative surface recombination and further enable advanced schemes for carrier confinement and device functionality. Focusing on the GaAs-AlGaAs core-shell NW model system, I will demonstrate the possibility to realize optically highly active NWs even at extreme size limits below 10 nm (well below the de Broglie wavelength), where strong quantum confinement effects appear. The GaAs-AlGaAs core-shell NW heterostructures represent further a very useful system for nanolasers coupled to Si photonic hardware. Here, we will see how these act as natural Fabry-Perot resonator cavities that lead to single mode lasing in directly integrated fashion on Si. Finally, also the potential of GaAs-AlGaAs core-shell NWs on steep-slope electronic switches will be presented based on high-mobility modulation-doped NW field effect transistors.

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