Near-field Optical Microscopy

Imaging and Spectroscopy at 10nm spatial resolution

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In this seminar I will introduce the Scattering-type Scanning Near-field Optical Microscopy (s-SNOM). This technique allows overcoming of the diffraction limit of conventional light microscopy or spectroscopy, enabling optical measurements at a spatial resolution of 10nm – not only at visible frequencies but also in the infrared or terahertz spectral range. Several applications of nano-imaging and spectroscopy on different materials will be presented.

s-SNOM employs an externally-illuminated sharp metallic AFM tip to create a nanoscale hot-spot at its apex. The optical tip-sample near-field interaction is determined by the local dielectric properties (complex refractive index) of the sample and detection of the elastically tip-scattered light yields nanoscale resolved near-field images simultaneous to topography.

Equipping s-SNOM systems with cw light sources near-field imaging can be performed at time scales of 30-300s per image. Use of material-selective frequencies in the mid-IR spectral range can be exploited to fully characterize polymer blends or phase change materials with nanometer-scale domains. Quantification of free-carrier concentration and carrier mobility in doped semiconductor nanowires, characterisation of plasmonic devices, analysis of Graphene nanostructures, or study phase propagation mechanisms in energy storage materials is achieved by amplitude- and phase-resolved infrared near-field imaging.

Development of a dedicated Fourier-transform near-field detection module for analysing light scattered from the tip that is illuminated by a broadband laser source enables IR spectroscopy (nano-FTIR) of complex polymer nanostructures. The patented modular system design enables straight forward integration of synchrotron-based broadband IR light sources or to realize ultrafast pump-probe near-field measurements.