Non-contact imaging of electrical conductivity with terahertz nanoscopy

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Terahertz (THz) technology is based on light sources with frequencies of 10^{12} Hz lying between microwaves and infrared light in the electromagnetic spectrum. THz light sources have a number of unique applications, for example for characterization of semiconductors since the plasma frequency of these typically falls within the THz range. Material properties like the electrical conductivity, refractive index, and carrier mobility can be extracted from a THz spectroscopy experiment, and this contact-free characterization method is highly attractive for semiconductor devices. Particularly, within applications of photovoltaics and the solar cell industry, THz systems have been used to study electron transport in new materials such as perovskites, where the surface tend to form grain structures that limit the efficiency. However, a general problem with THz imaging systems is that the spatial resolution is limited by the wavelength, which for THz sources is hundreds of µm.

In this presentation, we will demonstrate how to beat the diffraction-limit of THz light by orders of magnitude by taking advantage of plasmonic coupling to a sharp, metallic probe. With this, we are able to transfer the all benefits of THz technology to the nanoscale, and image material properties such as the electrical conductivity of semiconductor materials with a spatial resolution of 20 nm.