Imaging and spectroscopy at the nanoscale with scattering-type scanning near-field microscopy

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Scattering-type scanning near-field optical microscopy (s-SNOM) has established itself as a powerful tool for the characterization of optical phenomena at the nanoscale. Being able to spatially resolve fundamental low-energy excitations at the surface of solid-state systems, near-field imaging in the mid-infrared to far-infrared (THz) spectral range has resolved intriguing phenomena such as propagating exciton-, phonon-, and plasmon-polaritons [1-4] with a resolution of <10 nm.

This talk will introduce state-of-the-art applications of our neaSNOM microscope which strongly contribute to the research of low-energy electrodynamic phenomena. Using near-field technology propagating plasmon-polariton modes can directly be imaged on graphene[1,2] giving unique insights into the fundamental properties of the bare materials but also of devices and heterostructures. Near-field imaging can even be correlated to the detection of the tip-induced photocurrent[5,6], directly accessing the electronic properties of the material. Other applications of our neaSNOM include nano-FTIR spectroscopy of carrier densities in semiconductors[7] or the phonon-polariton resonances of antennas made from hexagonal boron nitride (h-BN)[4]. Ultimately, nano-FTIR can be combined with ultrafast pump-probe experiments adding femtosecond temporal resolution to the measurements, as seen in the probing of the ultrafast carrier-dynamics of InAs or graphene[7-9].

Finally, this talk will introduce our latest breakthrough in the field of near-field optics: cryogenic near-field optical microscopy using our closed-cycle-cooled cryo-neaSNOM. With this new approach it is possible to investigate all these materials at temperatures <10 K which opens up exciting new opportunities to study low-energy processes at the surface of solid-state systems (fig.1[10]).

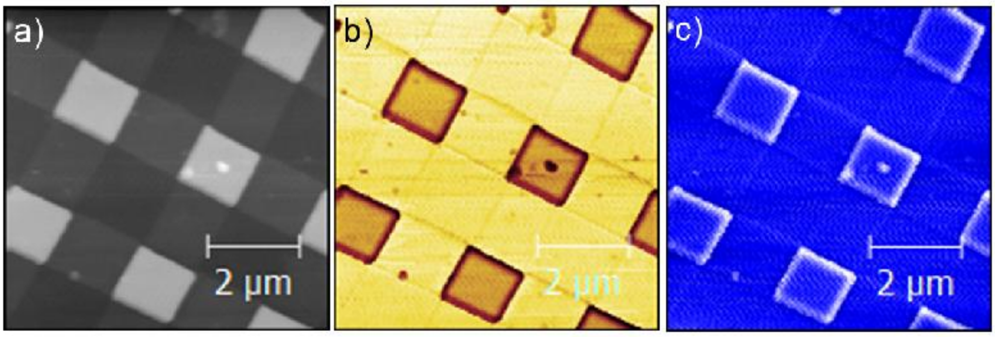

Figure. a) AFM topography and b) near-field amplitude and c) phase measured at 8.5 K sample temperature. The images demonstrate the high stability of the setup.

References

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