Aina Reich
Nicolai Hartmann, Tobias Gokus, Andreas Huber
neaspec GmbH, Eglfinger Weg 2, 85540 Haar, Germany
aina.reich@neaspec.com

Scattering-type scanning near-field optical microscopy as a versatile tool for the characterization of 1D and 2D materials.

Materials with strong confinement in one or two dimensions have shown large potential for new application due to their exotic properties, which are directly related to their nanoscale dimensions. It is often desirable to correlate properties, such as electronic structure and vibrational modes, to the material or nanostructure thickness and the nanoscale morphology.
One method that yields both local topography and can probe different optically excited transitions is scattering-type scanning near-field optical microscopy (s-SNOM). A metal-coated standard atomic force microscopy (AFM) probe is illuminated with light, which creates a nanofocus at the tip apex in which the electrical field of the incident light is amplified. The back-scattered light contains the information of the interaction of the sample with the nanofocus, with a spatial resolution dependent only on the tip apex radius[1]
With s-SNOM direct imaging of 2D material surface polaritons became possible for the first time. The graphene surface plasmon polaritons can be launched in the tip near-field and the interference of the waves directly imaged[1,2]. The discovery of the visualization of the polariton waves opened the field to the examination of all kinds of light–matter–interaction in 2D materials, including phonon polaritons and exciton polaritons[4] and also of phonon plaritons in 1D materials, such as InAs nanowires[5].
While the imaging of polariton waves is the most prominent application example, s-SNOM has recently also been used to characterize the conductivity of both carbon nanotubes[6] and single-layer graphene[7].

References

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Figures

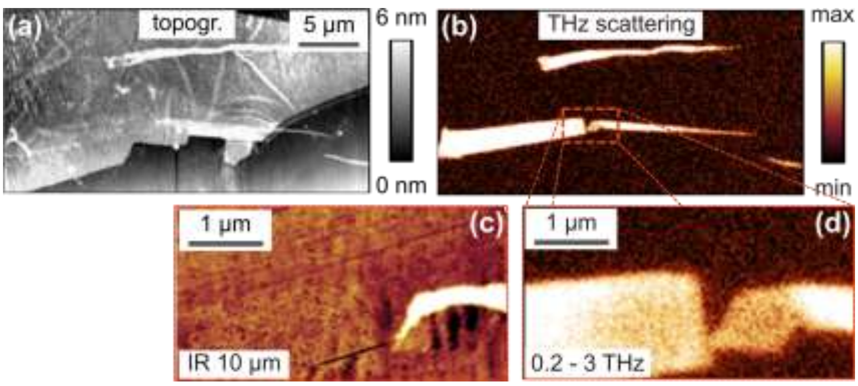

Figure 1: The conductivity of single layer graphene can be visualized through the s-SNOM contrast in the IR and THz spectral range. High reflectivity in the IR shows highly conductive areas, while those areas that are reflective in the THz spectral range are expected to have higher conductivity than the non-reflecting surroundings but lower conductivity than the areas that reflect IR light.