Infrared Near-field Spectroscopy - From Nanoscale Chemical Identification of Polymers to Real-space Imaging of Graphene Plasmons

Rainer Hillenbrand

CIC nanoGUNE Consolider, San Sebastian, Spain
Ikerbasque, Basque Science Foundation, Bilbao, Spain
r.hillenbrand@nanogune.eu

Abstract

During the last years, near-field microscopy based on elastic light scattering from atomic force microscope tips (scattering-type scanning near-field optical microscopy, s-SNOM [1]) has become a powerful tool for nanoscale optical imaging and spectroscopy. Acting as infrared antennas, the tips convert the illuminating light into strongly concentrated near fields at the tip apex (nanofocus), which provides a means for localized excitation of molecule vibrations, plasmons or phonons in the sample surface. Recording the tip-scattered light subsequently yields nanoscale-resolved infrared images, beating the diffraction limit more than two orders of magnitude.

Using broadband IR illumination and Fourier-transform spectroscopy of the tip-scattered light [2,3], we are able to record IR spectra with 20 nm spatial resolution (nano-FTIR). Particularly, we demonstrate that nano-FTIR can acquire near-field absorption spectra of molecular vibrations throughout the mid-infrared fingerprint region, allowing for chemical mapping and identification of polymer and protein nanostructures [3].

s-SNOM also enables the launching and detecting of propagating and localized plasmons in graphene nanostructures. Spectroscopic real-space images of the plasmon modes allow for direct measurement of the ultrashort plasmon wavelength and for visualizing plasmon control by gating the graphene structures [4.5].

References

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Figures

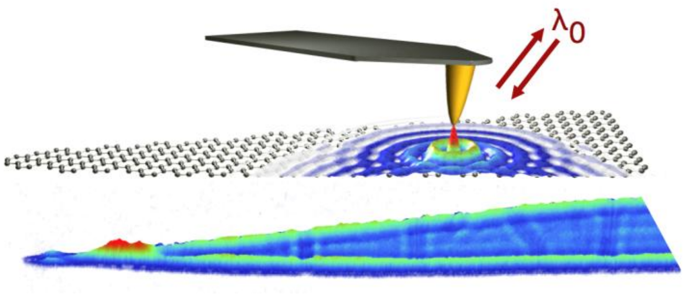

Figure 1: Figure: Optical nanoimaging of graphene plasmons. Upper panel: Sketch of the imaging method. A laser illuminated scanning tip launches plasmons on graphene. Detection is by recording the light backscattered from the tip. Lower panel: Optical image of graphene, where the fringes visualize the interference of the graphene plasmons.