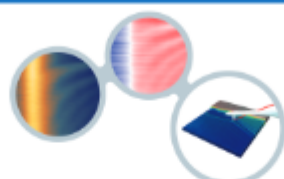


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Application Note #204

Spatiospectral Nanoimaging of Surface Phonon Plasmons

With their high spatial confinement, surface plasmon polaritons (SPPs) and surface phonon polaritons (SPPs) in 2D materials can open up new opportunities to enhance light-matter interaction, and enable the development of super lenses, subwavelength metamaterials, and other novel photonic devices. In-situ characterization of these polaritonic excitations across different applications requires a versatile optical imaging and spectroscopy tool with nanometer spatial resolution and wide spectral coverage. Through a non-invasive near-field light-matter interaction, a nanoIR3-s provides a unique way to selectively probe and locally detect electronic and vibrational resonances in real space.

The nanoIR3-s Broadband system provides a unique capability for nanoscale imaging and spectroscopy over the whole mid-infrared spectral range (2.5 μm - 15 μm / 4000 - 670 cm^{-1}) by coupling with a superbright broadband light source based on a terahertz QCL/DFG laser. While featuring high laser power and wide spectral range, this laser source can also switch its bandwidth for imaging (the low-bandwidth mode) and a spectral resolution of 4 cm^{-1} and spectroscopy (broadband mode >200 cm^{-1}).

The power of this technique can be demonstrated by studying the SPPs dispersion of hexagonal boron nitride (hBN). hBN has a hyperbolic optical permittivity near its two Reststrahlen bands in the mid-infrared region. Both its in-plane and out-of-plane optical permittivity has been plotted, with two resonances at 790 cm^{-1} for out-of-plane (ϵ_{\perp}) and 1325 cm^{-1} for in-plane (ϵ_{\parallel}), respectively (see Figure 1).

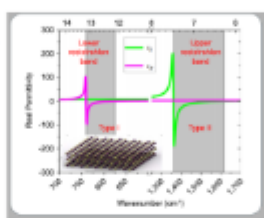


Figure 1 Local permittivity of hBN in the mid-infrared

Figure 2 shows the experiment schematic of a nanoIR3-s Broadband system (imaging a sample of hBN nanoflake). The IR light is tightly focused on the AFM probe and launches hBN SPPs at the tip apex. The excited SPPs propagate out along the surface and reflect back from sample edges, forming a standing wave pattern. Figure 3 shows an example of nano-FTIR spectrum collected at different locations on the hBN sample.

Spatiospectral Nanoimaging of Surface Phonon Plasmons

Surface plasmon polaritons (SPPs) in 2D materials enhance light-matter interaction and enable development of super lenses, subwavelength metamaterials, and other photonic devices. In-situ characterization of polaritonic excitations requires a versatile optical imaging and spectroscopy tool with nanometer spatial resolution and wide spectral coverage. The nanoIR3-s Broadband system provides a unique capability for nanoscale imaging and spectroscopy over the whole mid-infrared spectral range.

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