Peak Force Photothermal and Scattering-type Near-field Microscopy with Infrared Light Sources

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The combination of atomic force microscope (AFM) with infrared (IR) illuminations opens the route toward label-free spectroscopic imaging well below the diffraction limit. In the presentation, I will present our development of AFM-based infrared microscopy with the peak force tapping mode with two distinctive approaches of photothermal and optical detections. In the photothermal-based peak force infrared (PFIR) microscopy, the tip-enhanced infrared absorption is mechanically probed by the cantilever deflection of AFM through temporal gated detection. The PFIR microscopy allows the collection of both IR imaging and broadband spectroscopy with a quantum cascade laser. We have demonstrated the spatial resolution of the PFIR microscopy to be 6 nm in the air phase and ~10 nm in the liquid phase. The PFIR microscopy is also compatible with simultaneous measurement of mechanical properties and surface potential mapping. In the optical detection-based peak force scattering-type near-field optical microscopy (PF-SNOM), we demonstrated the extension of the scattering-type near-field microscopy to the collection of three-dimensional near-field responses. We observed the momentum localization of hyperbolic phonon polaritons in a boron nitride microdisk that is dependent on the tip-sample distance, as well as the tip-induced relaxation of phonon polaritons in silicon carbide. PF-SNOM also permits multimodal signal collection of mechanical properties and contact current in parallel with near-field imaging. In addition, I will present our work on the development of a compact ultra-broadband laser-driven plasma infrared source for nano-FTIR spectroscopy.