Recent Advances and Applications of Nanoscale IR Spectroscopy and Imaging

Miriam Unger

Miriam Unger, Anasys Instruments, Santa Barbara, CA, USA.

In conventional infrared microspectroscopy, the rule of thumb is that you cannot obtain IR spectra of objects smaller than 5-10 μm in size. This is based on the diffraction of radiation and therefore, the spatial resolution is limited to be on the order of wavelength of light used to make the measurement. Recently, researchers have developed new techniques that can overcome this limit, where the spatial resolution is not limited by diffraction. In this context, this presentation will focus on the combination of atomic force microscopy and infrared spectroscopy (AFM-IR) as well as scattering scanning nearfield optical microscopy (s-SNOM). Both techniques, AFM-IR and s-SNOM, are complementary with different strengths and weaknesses. AFM-IR directly detects IR radiation absorbed by the sample using the AFM probe tip to sense thermal expansion. This thermal expansion depends primarily on the absorption coefficient of the sample and is largely independent of other optical properties of the AFM tip and the sample. Thus, the AFM-IR technique is preferred to measure absorption spectra with correlation to conventional IR spectroscopy, and furthermore, can be widely used for studies of soft materials such as polymers and life science samples. On the other hand, s-SNOM detects radiation scattered by nanometer-scale regions directly under the AFM probe tip. The scattered field depends on the complex optical constants of both the tip and the sample and contains rich information about nano-optical phenomena. S-SNOM is an advanced technique for imaging nanoscale contrast based on optical properties, with diverse applications in advanced materials, devices and fundamental light/matter interactions. In this presentation, both the AFM-IR and s-SNOM approaches will be described and example applications of how they can be used to chemically characterize materials at the nanoscale.

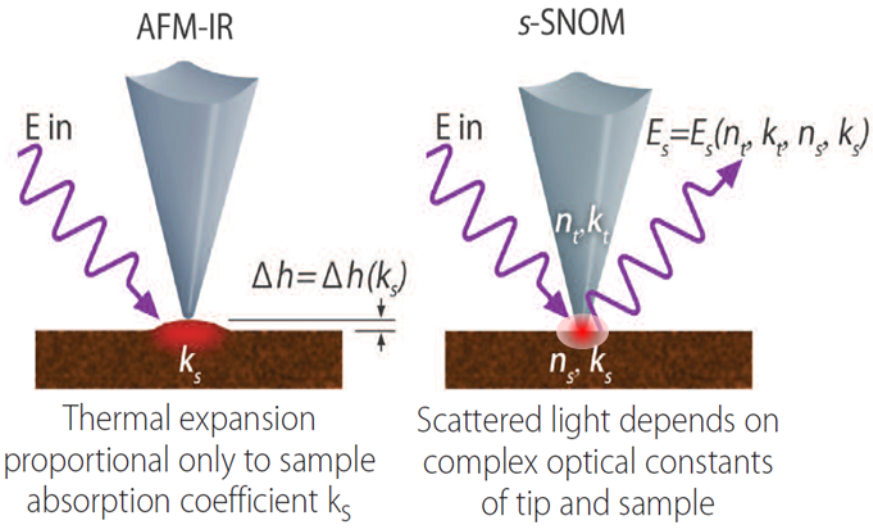

Figure: Close-up view of the laser light/AFM tip/sample interaction for the AFM-IR (left) and s-SNOM (right) experiments.