NANYANG TECHNOLOGICAL UNIVERSITY

PAP Seminar Announcement

Nano-FTIR: infrared spectroscopic chemical identification of materials at nanoscale.

By

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Venue: MAS Executive Classroom 1 (MAS-03-06)
Host: Asst. Prof. Cesare Soci , Asst. Prof Wang Qijie

Abstract

Fourier-transform infrared (FTIR) spectroscopy is an established technique for characterization and recognition of inorganic, organic and biological materials by their far-field absorption spectra in the infrared (IR) fingerprint region. However, due to the diffraction limit conventional FTIR spectroscopy is unsuitable for nanoscale resolved measurements.

We recently applied the principles of FTIR to scattering-type Scanning Near-field Optical Microscopy (s- SNOM) [1]. s-SNOM employs an externally-illuminated sharp metallic tip to create a nanoscale hot-spot at its apex which greatly enhances the near-field interaction between the probing tip and the sample. The light backscattered from the tip transmits the information about this near-field interaction to the far zone where the FTIR spectra can be recorded. The result is a novel nano-FTIR technique, which is able to perform near-field spectroscopy and imaging with nanoscale resolution.

Here we demonstrate Fourier-transform infrared nano-spectroscopy (nano-FTIR) based on a scattering-type scanning near-field optical microscope (s-SNOM) equipped with a coherent-continuum infrared light source. We show in that the method can straightforwardly determine the infrared absorption spectrum of organic samples with a spatial resolution of 20 nm. Corroborated by theory, the nano-FTIR absorption spectra correlate well with conventional FTIR absorption spectra, as experimentally demonstrated with PMMA samples (Fig. 1). Nano-FTIR can thus make use of standard infrared databases of molecular vibrations to identify organic materials in ultra-small quantity and at ultrahigh spatial resolution. As an application example we demonstrate the identification of a nanoscale PDMS contamination on a PMMA sample.

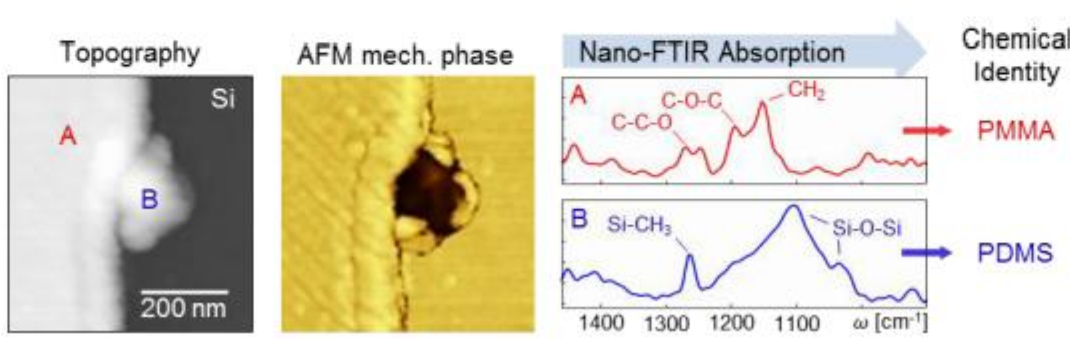

Fig. 1: In the topography image (left), a small sample contaminant (B) can be found next to a thin film of PMMA (A) on a Si substrate (dark region). In the mechanical phase image (middle) the contrast already indicates that the particle consists of a different material than the film and the substrate. Comparing the nano-FTIR absorption spectra at the positions A and B (right panel) with standard IR databases reveals the chemical identity of the film and the particle.

We envision that nano-FTIR will become a powerful tool for chemical identification of nanostructures, for investigating local structural properties (i.e. defects, strain) of crystalline and amorphous nanostructures, as well as for non-invasive measurement of the local free-carrier concentration and mobility in doped nanostructures.

[1] F. Huth, M. Schnell, J. Wittborn et al, Nat. Mater. 10, 352 (2011).
[2] S. Amarie, P. Zaslanky, Y. Kajihara et al, Beilstein J. Nanotechnol. 3, 312 (2012).
[3] F. Huth, A. Govyadinov, S. Amarie et al, Nano Lett 12, 3973 (2012).

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