AFM + Nanoscale Vis-IR Spectroscopy via Photo-induced Force Microscopy

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Abstract

Photo-induced Force Microscopy (PiFM) [1] combines optical spectroscopy and atomic force microscopy (AFM) via illumination of the tip-sample junction with tunable laser light and mechanical detection of forces acting on the tip in response to interaction of light with the sample. With infrared (IR) source, PiFM can map the IR absorption of the sample as a function of IR wavelength and position and achieve nm-scale resolution in displaying the locations of heterogeneous materials on the surface of a sample. Even for samples without active IR absorption band, PiFM can be used to acquire nanoscale mapping based on the dielectric constant of the sample surface; dielectric constant mapping also allows high resolution sub-surface mapping. With tunable visible and near infrared (VisNIR) laser source, PiFM can map exciton resonances with similar spatial resolution even on monolayer samples. Examples from various classes of samples including organic, inorganic, and 2D materials will be presented. We will also present PiFM spectroscopy data that show excellent correlation with bulk FTIR spectra despite the fact that PiFM acquires local chemical information from regions in the range of 10 nm in extent.

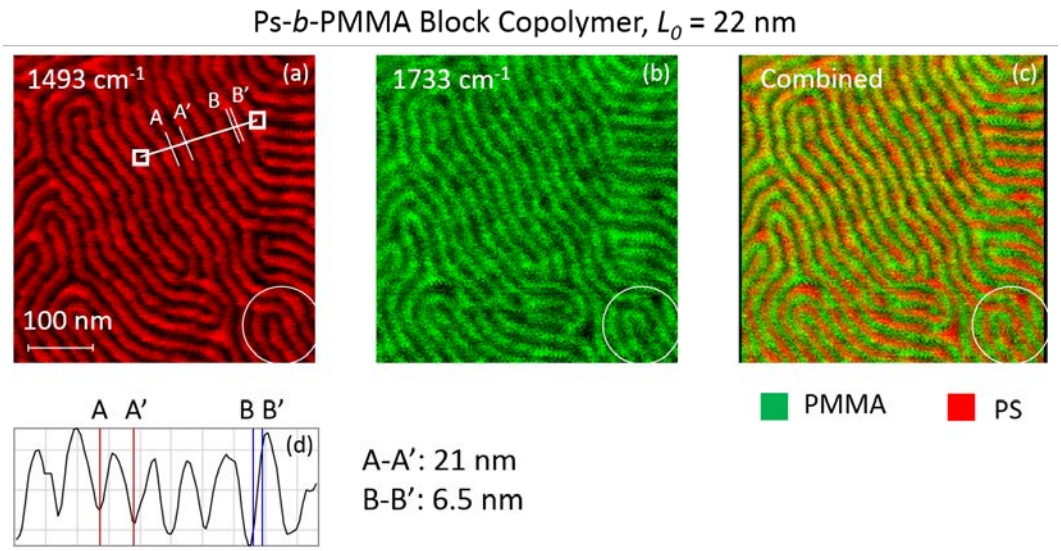

Figure 1: PS-PMMA block copolymer imaged via PiFM (a) PS molecules at 1493 cm^{-1} (b) PMMA molecules at 1733 cm^{-1} (c) images (a) and (b) combined to map different molecules (d) cross-sectional view demonstrating sub-10 nm spatial resolution. The features highlighted by the white circles clearly show the complementary arrangement of the different molecules.

References:

[1] D. Nowak et al., "Nanoscale chemical imaging by photoinduced force microscopy", Sci. Adv. 2, e150157 (2016).