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Atomic force and shear force based tip-enhanced Raman spectroscopy and imaging

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Abstract

Underlying near-field optical effects on the nanoscale have stimulated the development of apertureless vibrational spectroscopy and imaging with ultrahigh spatial resolution. We demonstrate tip-enhanced Raman spectra of single-walled carbon nanotubes (SWCNTs), recorded with a scanning near-field optical spectrometer using both atomic force (AF) and shear force (SF) feedback lock-in regulation, and critically discuss the advantages and drawbacks of both operation modes. For accurate calculation of the enhancement factor obtained, we have analysed the tip shape and diameter by means of scanning electron and transmission electron microscopy (SEM and TEM). In our experiments we reproducibly attain diameter-corrected and area-corrected enhancement factors of up to ~104 and ~105, respectively, estimated as the linear ratio of near- and far-field intensities, and we are able to demonstrate near-field Raman imaging of SWCNTs with spatial resolution better than 50 nm.

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