Localized surface curvature artifacts in gap-mode tip-enhanced nanospectroscopy

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Abstract (Century Gothic 11)

Carbon nanomaterials including graphene and other two-dimensional materials are being successfully investigated by Raman spectroscopy and nano-Raman (or tip-enhanced Raman spectroscopy, TERS). The latter allows for chemical analysis to exceed the limit of light diffraction and to distinguish very similar carbon nanostructures on a small scale.[1] In most experiments, the high-spatial sensitivity is provided by the metal substrate in the so-called gap-mode TERS. However, in this case, the connection between the tip and the sample could lead to distortions in the image of the nanostructure during visualization. The purpose of this poster contribution is to provide a generalized view of such image artifacts in TERS imaging and to find out whether these effects occur and to what extent. The change in the curvature of the surface by introducing a PMMA polymer results in 6-fold amplification of the Raman scattering signal. In the case of isolated Au particles, the signal on the CoPc film is 12 times more intense than that on the Si substrate. In addition, we found that the sample curvature in the gap mode introduces TERS imaging artifacts visible as distortions in the distribution of the electromagnetic field. Finally, a weak additional enhancement of the Raman signal is observed through a thick organic layer > 40 nm.
These results demonstrate that the use of gap-mode significantly increases the signal strength, but that at the same time, the sample curvature makes an impact to the TERS image contrast. We provide an analysis of TERS artifacts in these conditions. Beyond metal nanoparticles functionalized with organic molecules, our conclusions impact the nanoscale chemical visualization of two-dimensional materials and ultra-thin layers by TERS.

References

[1] Sheremet, E.; Rodriguez, R. D.; Agapov, A. L.; Sokolov, A. P.; Hietschold, M.; Zahn, D. R. T. Nanoscale Imaging and Identification of a Four-Component Carbon Sample. Carbon N. Y. 2016, 96, 588–593.

Figures

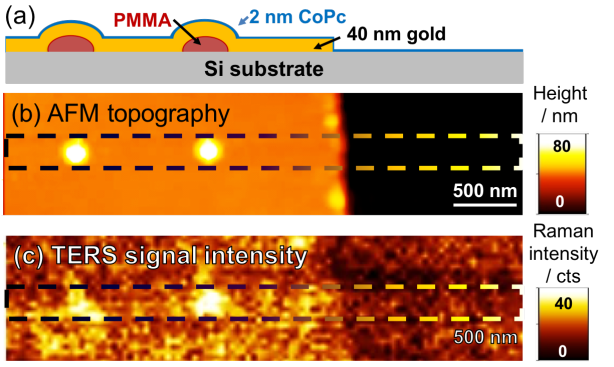

Figure 1: TERS imaging of the sample with different surface curvature. (a) Sample cross-section; (b) AFM image of the surface; (c) TERS image of the mode at 682 cm^{-1}.

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