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Quantitative Analysis of Scanning Tunneling Microscopy Images of Functionalized Nanoparticles"

Abstract

Ligand-protected gold nanoparticles exhibit large local curvatures, features rapidly varying over small scales, and chemical heterogeneity. Their imaging by Scanning Tunneling Microscopy (STM) can, in principle, provide direct information on the architecture of their ligand shell, yet STM images require laborious analysis and are challenging to be interpreted. Here, we report a straightforward, robust and rigorous method for the quantitative analysis of the multiscale features contained in STM images of samples consisting of functionalized Au nanoparticles deposited onto Au/mica. The method relies on the analysis of the topographical power spectral density (PSD), and allows us to extract the characteristic length scales of the features exhibited by nanoparticles in STM images. For the mixed-ligand protected Au nanoparticles analyzed here the characteristic length scale is 1.1±0.1 nm, whereas for the homoligand Au NPs this scale is 0.5±0.2 nm. These length scales represent spatial correlations independent of scanning parameters, and hence the features in the PSD can be ascribed to a fingerprint of the STM contrast of ligand-protected nanoparticles. PSD spectra from images recorded at different laboratories using different microscopes and operators can effectively be overlapped, proving that the features in the STM images of nanoparticles can be compared and reproduced.