

銀ナノワイヤーを用いた探針増強ラマン散乱プローブ

Silver Nanowire Based Tip-Enhanced Raman Scattering probe



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Tip-enhanced Raman scattering (TERS) microscopy is a unique analytical tool to provide complementary chemical and topographic information of surfaces with high spatial resolution at nanometer scale. However, difficulties in reliably producing the necessary metallized scanning probe tips have limited its widespread utilization, particularly in the case of cantilever-based atomic force microscopy (AFM). Here we demonstrate the reproducible fabrication of cantilever-based high performance TERS probes, based on an approach that utilizes silver nanowires (AgNWs, Fig.1a). The tips show 10 times higher TERS contrasts than the most typically used electrochemically-etched tips, and show reproducibility for TERS greater than 90% (Fig.1 b-d). We show that TERS can be performed in tapping as well as contact AFM mode, with optical resolutions around or below 15 nm, and with a maximum resolution achieved in tapping-mode of 6 nm. For further improvement of our probe's performance, we utilize electrical cutting allowing strategically modification tip apex morphology. This doubles TERS signals on a gap-mode substrate compared to our standard nanowire tips while maintaining a high reproducibility and spatial resolution. More interestingly, the cut tips show 7 times higher signals on a dielectric substrate than our standard tips. Our works illustrate that superior TERS probes can be produced in a fast and cost-effective manner using simple wet-chemistry methods, leading to reliable and reproducible high-resolution and high-sensitivity TERS.

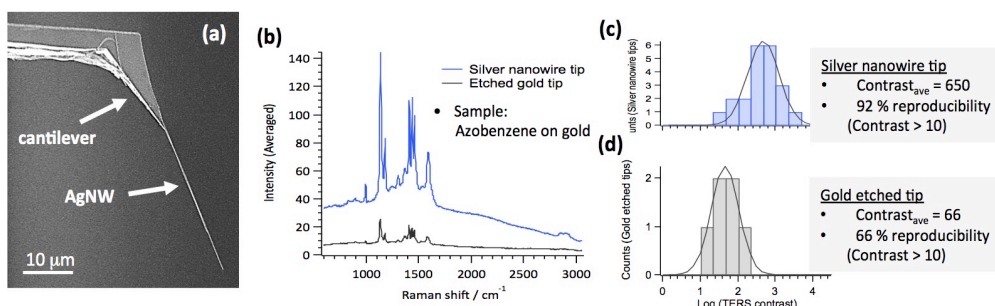


Figure 1 (a) Typical SEM image of the AgNW based TERS tip. (b) Typical spectra of azobenzene-thiol on an Au(111) surface, recorded with the AgNW (blue) and etched Au tip (black), respectively. (c, d) Histograms of the logarithmic TERS contrast for the AgNW (c) and etched Au (d) tips, along with fitted Gaussian profiles in each case.