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Gold Nanoparticle Aggregations on Recyclable Hierarchical Nanotrays for Surface-enhanced Raman Spectroscopy with Macroscale Uniformity

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We present a novel nanofabrication process to manufacture recyclable hierarchical silicon/alumina nanotrays (SANTs). Highly ordered arrays of SANTs were made by IC-compatible processes over entire wafers. Gold nanoparticles were pinned to SANTs (see figure 1), enabling the structures to be used for surface-enhanced Raman spectroscopy (SERS). The gold nanoparticles further detached themselves from SANTs upon drying of analyte solvent, and subsequently formed aggregations with nanogaps, inside which the SERS hot spots and the analytes were simultaneously located. Such a substrate demonstrated a high average SERS enhancement factor of ~2×10^8, with a macroscale SERS uniformity of 6% CV across 40 mm (obtained from 41 evenly distributed data points). Furthermore, after SERS analyses, the SANTs were recycled by complete removal of gold via wet etching. The reused substrate exhibited very low SERS backgrounds as well as excellent SERS reproducibility, in comparison to those obtained on a new substrate.

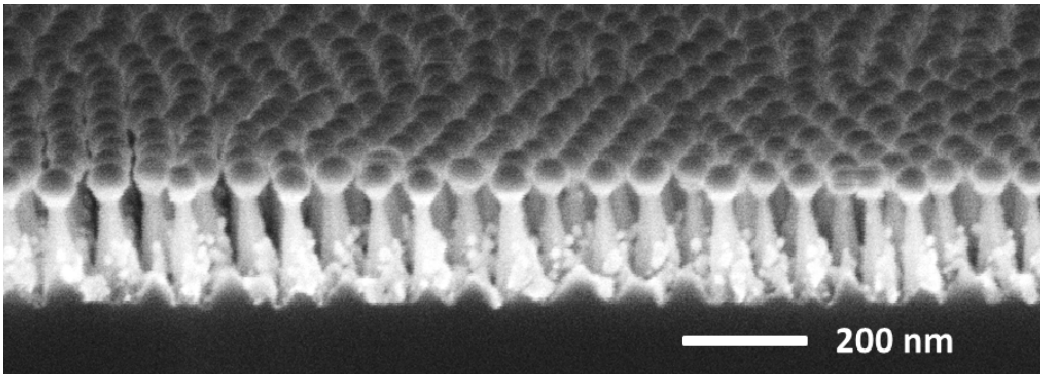

Figure 1 An SEM image of silicon/alumina nanotrays (SANTs) with gold nanoparticles pinned on their tops, which consist of a thin layer of alumina nanodisks (~10 nm). The alumina disks are suspended on cone-shaped silicon nanospikes. The structures were fabricated on a 2-inch silicon wafer.