NANOPARTICLE FORMATION FROM AU THIN FILM ON FLAT AND PATTERNED SILICON SURFACE

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The nanoparticles' size, shape and position on the surface play a crucial role in surface-enhanced Raman spectroscopy (SERS). While various techniques have been developed to control individual nanoparticle characteristics, achieving simultaneous control over all parameters remains a significant challenge. Therefore, a combination of focused ion beam lithography and dewetting of thin Au film to nanoparticles is studied as a potential method for controlling nanoparticle size, shape and positioning on the surface.

In this work, gold films with thicknesses of 10 nm and 30 nm were sputtered onto silicon wafers. The formation of Au nanoparticles was induced by thermal dewetting of the thin films at elevated temperatures of 700℃, 800℃, and 900℃ in a quartz tube. The resulting nanoparticles were characterized using scanning electron microscopy (SEM) to assess their morphology and size distribution. Additionally, FIB was employed to etch three distinct dumbbell-shaped pit patterns into separate silicon wafers, followed by sputtering a 10 nm Au film onto each wafer. Subsequent heating at the same temperatures facilitated the formation of nanoparticles within these predefined patterns.

SEM image analysis provided insights into the nanoparticle shapes and their size distributions, while the positioning of nanoparticles within the FIB-etched pits was further investigated using transmission electron microscopy (TEM). The results demonstrate that the nanoparticle size increases with the thickness of the Au film, while their shape is influenced by the dewetting temperature. Furthermore, the spatial positioning of the nanoparticles can be modified through the use of pre-patterned silicon surfaces.