High-Performance SERS Substrates Based on Au/Ag Coated Nanoconvex Polymer Lattices

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Applications in medical diagnostics, environmental monitoring, and food safety increasingly demand analytical tools capable of detecting ultra-low concentrations of analytes with high sensitivity and reproducibility. Surface-Enhanced Raman Scattering (SERS) has emerged as a powerful technique in this context; however, the fabrication of reliable, sensitive, and cost-effective SERS substrates remains a significant challenge.

In this study, we present an innovative approach to developing hierarchical plasmonic lattices by integrating gold and silver nanodots (Au&Ag_NDs) onto nanoconvex polymeric substrates using a template replica-assisted nanoimprinting technique. The method begins with the anodization of aluminum substrates using oxalic and phosphoric acids to generate well-defined nanoconcavities. These nanostructures are subsequently coated via magnetron sputtering and thermally annealed to induce the formation of uniformly distributed metallic nanodots.

The resulting plasmonic nanostructures are then successfully transferred to polymethyl methacrylate (PMMA) films, yielding flexible and scalable Au&Ag_ND_PMMA platforms. These platforms exhibit excellent SERS activity, characterized by high sensitivity, reproducibility, and tunable optical properties that can be achieved through the control of structural parameters. Their performance was validated using rhodamine B (RhB) as a probe molecule, achieving a detection limit as low as 10^{-8} M and an enhancement factor (EF) on the order of 10^{7}. The proposed fabrication strategy offers multiple advantages: it is low-cost, compatible with large-area production, and does not require sophisticated nanofabrication infrastructure. These features make it especially promising for real-world applications, including point-of-care diagnostics, environmental pollutant detection, and food contamination analysis. Future research will aim to optimize the design parameters of the plasmonic lattices further and explore their performance in detecting a broader range of biomolecules and chemical analytes for multiplexed biosensing applications.

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Figures

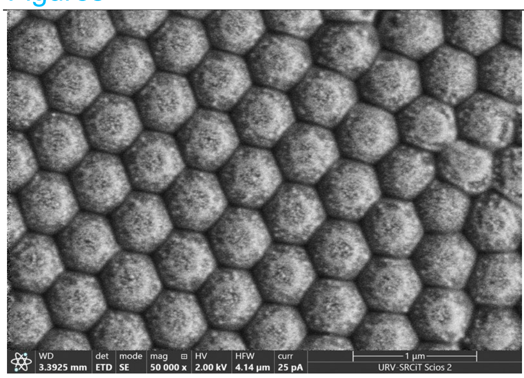

Figure 1: Al nanoconcavities Substrates prepared with Phosphoric acid and coated with PMMA to get the imprinting of the concavities decorated with Au nanodots.