Engineering of Au-Al nanopatterned substrates as platforms for SERS detection.

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From its early 1974 description, surface-enhanced Raman scattering (SERS) has attracted considerable attention due to its potential utility in a wide variety of fields throughout the life sciences, including analytical chemistry, biomedicine, agriculture, and more. To create SERS-based ultrasensitive sensors of diverse substances, highly branched metal nanostructures are of great interest [1].

Our results provide a robust strategy for assembling Au nanoparticles (NP) into Al high-density nanoarrays with high spatial resolution, providing intense electromagnetic fields for plasmonic sensor applications. With the help of a two-step anodization technique [2], we were able to replicate the unique honeycomb structure and its ability to build Au nanoparticle patterns on arrays of honeycomb-like Al nano bowls.

The initial anodization step of a two-step anodization process consisted of the application of 40 V to Al sheets in an oxalic acid electrolyte at 5 °C for 20 hours. The pattern formed on the Al template during this initial anodization was removed by immersing the samples in an etching solution of 1.8% chromic acid and 6% phosphoric acid (etching solution) for 3 hours at 70 °C. Then a second anodization step for three further hours was done under the same initial step parameters [2]. Finally, the samples were treated with the same previously used etching solution for 2 hours at 70 degrees Celsius to remove the formed nanoporous alumina, as shown in Fig 1. A thin coating of gold was deposited on the prepared Al nano bowl substrates using RF magnetron sputtering (BESTEC, magnetron sputtering system). Thereafter, the nano bowl substrates with the Au films were annealed at various temperatures and time intervals.

The Au film sputtering time and the annealing conditions affected the AuNP size and distribution. These electrochemically produced nanoarrays provide high spatial resolution due to dense Au NPs. Their plasmonic characteristics, experimentally measured from the visible to the NIR region, with significant Enhancement Factors for molecule detection, make them excellent substrates for sensitive applications like SERS [3]. This work will enable rapid identification and classification of target analytes in clinical applications, food safety, environmental pollution, chemical hazards, and label-free detection of DNA, proteins, viruses, cells, and other biological systems.

References

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Figures

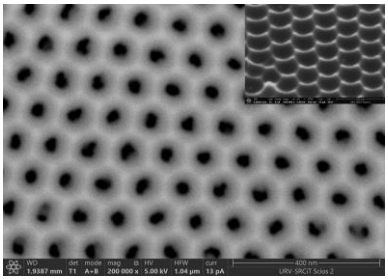

Figure 1: Porous morphology of the alumina layer. Inset: Al nanoconcavities.