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Fabrication of Porous Gold-Silver Alloy Nanowires Array via Controlled Dealloying Process: a Simple Approach for Highly Stable and Sensitive SERS Substrate

Surface enhance Raman scattering (SERS) has received a great interest as a powerful tool for enhancing the Raman characteristic peaks of molecules. For commercial purpose, SERS substrate is practically required to accomplish all four features, which are high sensitivity, reproducibility, uniformity and ability to provide stable Raman signal. There are a few works of developed SERS substrates that meet all the requirements. However, an approach for fabrication of SERS substrate for the long-term stability without reduction of sensitivity has not yet been reported.

This work presents a simple approach for fabrication of porous gold-silver alloy nanowires array as SERS substrate. The highly ordered two-dimensional (2D) array of gold-silver alloy nanowires (AuAg NWs) was first created via template-based electrochemical deposition, followed by the controlled dealloying process. Systematic study of the controlled dealloying process revealed that the porous nanowires array maintaining their rigid nanostructures was successfully obtained when using mild acid etching. SERS performance of the fabricated substrates was fully evaluated using 4-mercaptobenzoic acid (4-MBA) as a probe molecule. Exceedingly, a 150-fold Raman signal with respect to typical gold film substrate was obtained. Additionally, uniformity in Raman signal in both macroscopic and microscopic area was obtained. For the large-area uniformity, SERS signal within a circular area of 2-cm diameter was examined and given the acceptable relative standard deviation (RSD) less than 12.16% (n =12). While, the uniformity of Raman signal in a microscopic area was investigated by Raman mapping in the square area (100x100 µm2). The result shows the exceptional RSD less than 3% for 16,384 individual spectra. Moreover, an excellent stability of our SERS substrate was also continuously monitored, with 100% of the initial Raman signal over a month and the detectable signal over 3 months of storage at room temperature. According to the result of SERS performance testing, it is obviously seen that our proposed route by simple controlling of dealloying process can provide an excellent SERS substrate for further applications in bio- and chemical sensors.

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