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Preparation of Silver and Silver-Gold, Universal and Repeatable, Surface Enhanced Raman Spectroscopy Platforms from SERSitive

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Abstract : Surface Enhanced Raman Spectroscopy (SERS) is a technique of growing importance not only in purely scientific research related to analytical chemistry. It finds more and more applications in broadly understood testing - medical, forensic, pharmaceutical, food - and everywhere works perfectly, on one condition that SERS substrates used for testing give adequate enhancement, repeatability, and homogeneity of SERS signal. This is a problem that has existed since the invention of this technique. Some laboratories use as SERS amplifiers colloids with silver or gold nanoparticles, others form rough silver or gold surfaces, but results are generally either weak or unrepeatable. Furthermore, these structures are very often highly specific - they amplify the signal only of a small group of compounds. It means that they work with some kinds of analytes but only with those which were used at a developer's laboratory. When it comes to research on different compounds, completely new SERS 'substrates' are required. That underlay our decision to develop universal substrates for the SERS spectroscopy. Generally, each compound has different affinity for both silver and gold, which have the best SERS properties, and that's what depends on what signal we get in the SERS spectrum. Our task was to create the platform that gives a characteristic 'fingerprint' of the largest number of compounds with very high repeatability - even at the expense of the intensity of the enhancement factor (EF) (possibility to repeat research results is of the uttermost importance). As specified above SERS substrates are offered by SERSitive company. Applied method is based on cyclic potentiodynamic electrodeposition of silver or silver-gold nanoparticles on the conductive surface of ITO-coated glass at controlled temperature of the reaction solution. Silver nanoparticles are supplied in the form of silver nitrate ($AgNO_3$, 10 mM), gold nanoparticles are derived from tetrachloroauric acid (10 mM) while sodium sulfite (Na_2O_3, 5 mM) is used as a reductor. To limit and standardize the size of the SERS surface on which nanoparticles are deposited, photolithography is used. We secure the desired ITO-coated glass surface, and then etch the unprotected ITO layer which prevents nanoparticles from settling at these sites. On the prepared surface, we carry out the process described above, obtaining SERS surface with nanoparticles of sizes 50-400 nm. The SERSitive platforms present highly sensitivity (EF = 10^5-10^6), homogeneity and repeatability (70-80%).

Keywords : electrodeposition, nanoparticles, Raman spectroscopy, SERS, SERSitive, SERS platforms, SERS substrates
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