Highly efficient Plasmonic Nanostructured Surfaces for ultra-sensitive detection of trace analytes by Surface Enhanced Raman Spectroscopy

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The design of efficient, cost effective SERS plasmonic substrates is one the most important areas of research in the SERS field. Hot-spots, where the enhancement factor (EF) is higher, occur mainly between two nanoparticles (NP) with a distance < 10 nm or at sharp edges of non-spherical nanoparticles (NPs) such as star shaped NPs. In this work, highly homogenous dispersions of spherical Ag NPs in a silicon surface were obtained through a dewetting method, followed by annealing at high temperatures. This leads to the formation of nanoparticles with a tunable size (20–200 nm). This method can be adapted to a great variety of substrates such as cardboard surfaces providing very cheap disposable SERS active surfaces [1].
To improve the SERS detection sensitivity of these surfaces, a chemical method [2] was employed to synthesize Ag nanostars in solution followed by a covalent linkage to the silver spheres on the surface, originating a type of "sandwich" substrate that combines different types of hotspots. The substrates were characterized by SEM and show a very homogenous deposition of silver spherical particles and also, in the second step, of silver stars. The substrates were tested for SERS activity using rhodamine-6G - a model dye for SERS – and a 633 nm laser. The results show a EF factor of $1x10^6$ for the substrates only with the spherical Ag NPs and an EF up to 4 orders of magnitude higher for the "sandwich" substrates. Studies are underway to improve the obtained EF as well as expanding the work to relevant analytical molecules such as pesticides and food toxins.

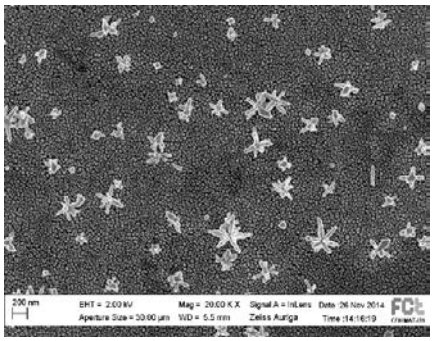

Fig. 1: *High magnification SEM microphotograph of the "sandwich" substrates*

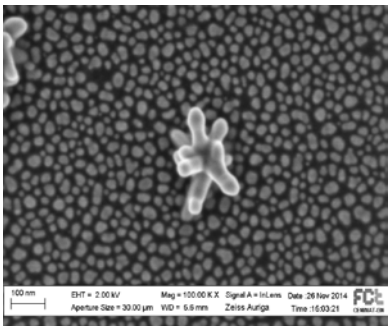

Fig. 2: *High magnification SEM microphotograph showing silver star on a spherical NPs-covered silicon surface*

[1] Araujo, A. et al. Nanotechnology, 2014. 25(41): p. 415202.

[2] Garcia-Leis A. et al. J. Phys. Chem. C, 2013, 117 (15), pp 7791−7795