New SERS substrates made of polymers and Al, cheap and highly efficient.

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Abstract

Raman signals are inherently weak, so a low number of scattered photons are available for detection, Surface Enhanced Raman Scattering (SERS) is a useful method to amplify weak Raman signals by an increment of the apparent Raman cross-section [1].

SERS uses nanoparticles or structured metal surfaces typically made of noble metals, commonly gold (Au) or silver (Ag). Laser excitation of these metal nanostructures resonantly drives the metal surface charges creating highly localized plasmonic light fields at these photonic structures, which we know as hot-spots. When a molecule is bonded, adsorbed or lies close to the enhanced field of a hot-spot at the surface, a large enhancement in the Raman signal can be observed, -usually of several orders of magnitude- thereby making it possible to detect concentrations as low as 10^{18}M of target molecules [2].

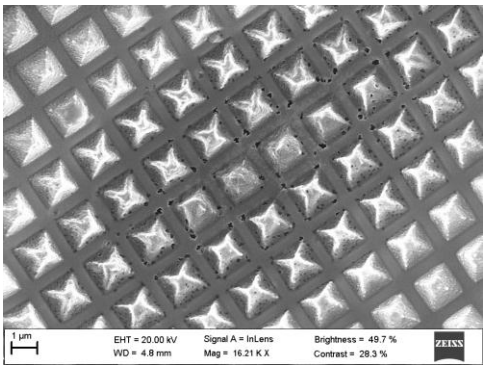
The main problem to use SERS as everyday lab technique is the lack of appropriate substrates. The number of available commercial substrates is scarce and they are expensive and quite unstable, requiring to keep them in controlled atmospheres and a careful handling to maintain their enhanced properties. Important research efforts try to provide cheap and reliable substrates [3]

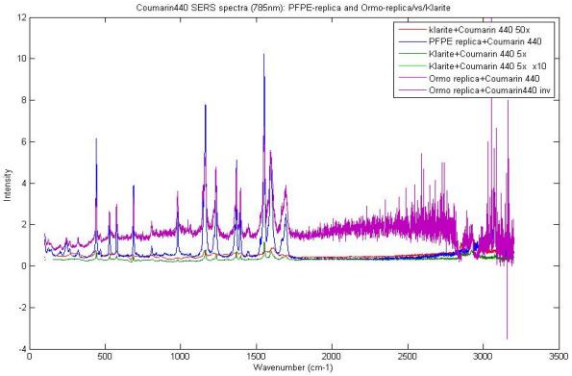
In this work we show our results testing home-made SERS substrates based in an easy and cheap fabrication process comprising just two steps: a replica molding based on a UV-NIL like process, and coating of a thin layer of metal (Au, Ag), Al, or Ir by sputtering with Ar plasma or coated by PVD. As supporting material we choose a crosslinkable tetrafuntional perfluoropolyether derivate [4], and a commercial ormocer photoresist.
The experiments show an uniform SERS enhancement of several orders of magnitude over the structured substrates when tested with organic analytes like Rhodamine 6G, Coumarin 440 or Rhodamine B, using a excitation laser of 785nm working at 1 or 0.1mW . The signal enhancement is comparable or higher than that obtained with commercial substrates.

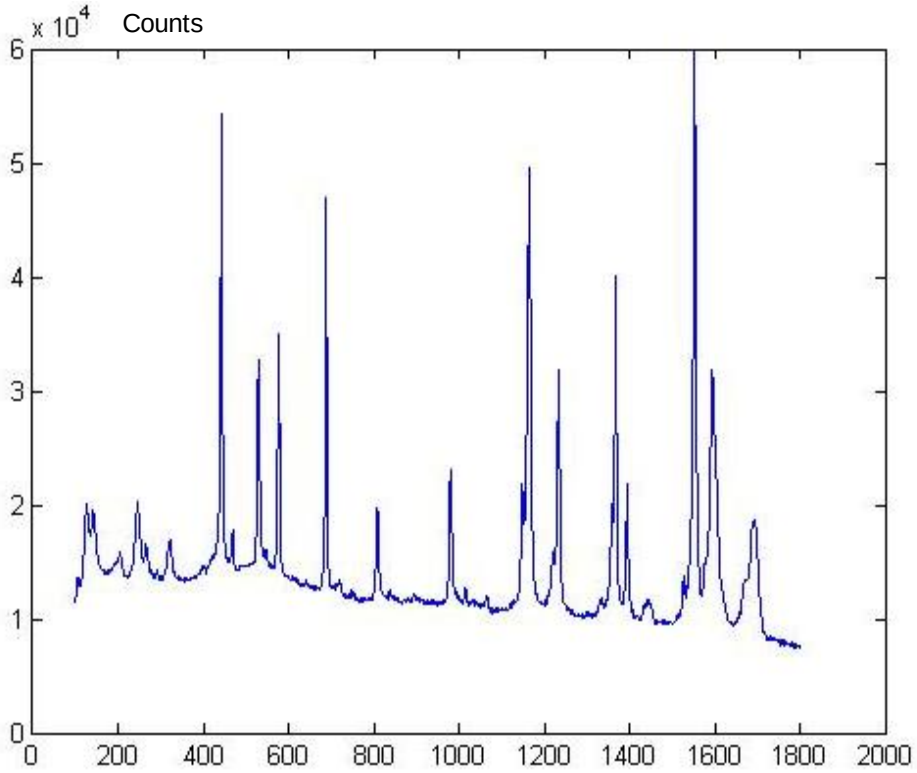
Aluminum coated substrates with comparable or even better enhancement of signal respect to the same substrates made of gold reduces even more the cost of these substrates. Additionally no change in the intensity of the spectra was observed after a month of storage at room conditions.

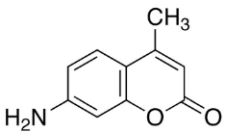
With this simple, fast and versatile molding process, it is possible to produce polymer SERS substrates with extremely low cost, high throughput, and in a highly repeatable way.

Figures









Coumarin 440

Substrate: Structured PFPE +Al

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