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Can a low-cost nano-rough gold substrate compete with commercial SERS substrates?

Surface Enhanced Raman Spectroscopy (SERS) is a powerful non-invasive technique to detect and identify traces of molecules in a complex mixture. The accurate identification of molecules is based on the detection of distinctive vibrational modes characteristic of molecule adsorbed onto the surface. Thus, it is essential that the SERS support provides a SERS signal with the best spectral quality and sufficiently distinct from the noise signal of a control sample. We recently optimized an experimental procedure to elaborate nanorough (RMS= 2 ± 0.2 nm) gold SERS substrates. In order to verify the detection capability of our substrate for sensing applications, we compared its sensitivity to three different commercial SERS substrates: Gold nanostructured supports from Hamamatsu (Japan), Premium Ag-Au supports from SERSitive (Poland) and RAM-SERS-Au from Ocean Insight (USA). SERS substrates were dipped into solutions of thiophenol (molecule commonly used in detection test) at 10^{-6} M and 10^{-8} M. SERS measurements were performed systematically over an area of 20 × 20 µm² with 632.8 nm and 785 nm wavelength excitations. Depending on the topography and roughness of the substrates (Figure 1 B), x50 or x100 objectives were used. The map spectra were collected for quantitative and statistical SERS analysis. As an example, the average spectra of each map can be compared in Figure 1 A. Our results demonstrate that it is not the most sensitive (Raman intensity / Laser power ratio) SERS substrate that necessarily generates the best quality (low baseline intensity and high signal-to-noise ratio) spectra. We will show how our nanorough gold substrate can detect and identify model molecules in binary systems by using statistical tools and multivariate data analysis.

Figures

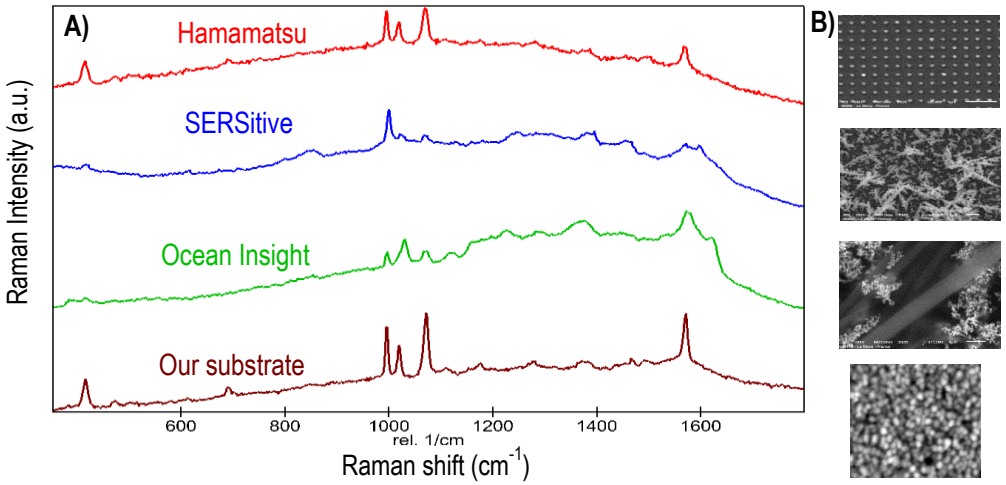

Figure 1: A) Average SERS spectra of thiophenol on Hamamatsu (red), SERSitive (blue), Ocean Insight (green) and on the nanorough gold substrate (brown) at 633 nm, after immersion in a 10^{-8} M thiophenol solution. B) SEM images of Hamamatsu, SERSitive and Ocean Insight surfaces, and AFM image of our substrate.