SERS substrates fabricated with star-like gold nanoparticles for zeptomole detection of analytes

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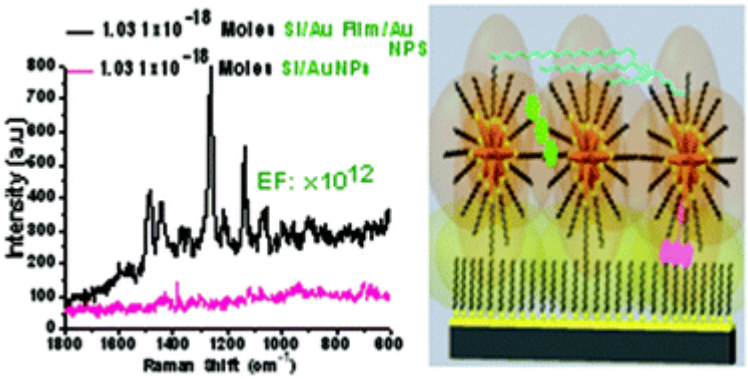
Abstract.

This work presents the design of substrates for Surface Enhanced Raman Scattering (SERS) using star-like gold nanoparticles which were synthesized using a wet chemical method and functionalized with 1-dodecanethiol. This molecule allowed us to obtain a spacing of ~2.6 nm among gold stars, which promoted the generation of SERS hotspots for single molecule detection. The gold nanoparticles were deposited on silicon substrates or on gold coated silicon substrates by using the Langmuir–Blodgett method which permitted the zeptomole detection of Rhodamine B (total moles per laser spot area). The Raman enhancement factor (EF) achieved for this level of detection was 1012, and was obtained on the SERS substrate fabricated with the configuration: Si/Au film/Au nanoparticles. Raman spectra of the molecules TWEEN 20 and p-terphenyl were also measured in order to elucidate the effect of the molecule's length on the enhancement factor. According to these results, our SERS substrates without the gold film are useful for a minimum detection level of ~10–14 moles of analytes with sizes equal to or less than 1.3 nm and ~10–18 moles of analytes with the gold film (total moles per sample).



Graphical abstract: SERS substrates fabricated with star-like gold nanoparticles for zeptomole detection of analytes