

Low-cost nanopatterned SERS substrates for very low concentration detection of antibiotics

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The excessive and inappropriate use of antibiotics in many areas like medicine, animal feeding and agriculture [1, 2] can be associated with a wide range of adverse health effects in humans like the development of antibiotic resistance, immunological weakening, toxicity to the liver, carcinogenicity, or many other severe health effects [3-7]. For this reason, the detection of antibiotics at trace levels is of the highest importance in several areas like clinical diagnostics, pharmaceutical quality control or environmental monitoring, among others [8,9].

Traditional technologies for the detection of ultra-low concentrations of antibiotics are expensive, time-consuming and require qualified and experienced staff to obtain precise and reliable results. Hence, the development of novel methods for the quick, easy, and accurate detection of antibiotics is a significant objective. Surface-enhanced Raman spectroscopy (SERS) is an interesting method for molecular sensing with applications in many different areas, like materials science, biochemistry or biosensing [10-12]. Several SERS platforms based on nanoparticles, nano stars, nanopyramids, or hybrid materials have been developed with the main challenge of magnifying the Raman signal and identify the chemical structures [13,14].

In the present work, aluminum substrates patterned with nanoconcavities and covered with ordered silver nanoparticles (Figure 1) are developed for the SERS detection of antibiotics at very low concentrations. The hexagonal aluminum nanoconcavity patterns were fabricated using a cost-effective approach based on self-ordered nanoporous anodic alumina [15-18]. The resulting structural parameters, such as nanoconcavity diameter and inter-nanoconcavity spacing, are precisely controlled by the anodization conditions of aluminum and strongly determine the silver nanoparticles distribution [19,20].

These substrates exhibit an outstanding plasmonic enhancement provided by the highly ordered metallic nanoparticles and the special and well defined nanopatterning of the aluminum surface, properties that greatly enhance the Raman signal of the antibiotic molecules. Detection limits approaching the 10^{-10} M concentration level demonstrate that these substrates are completely

suitable for the successful detection of various antibiotics, including Amoxicillin and Tetracycline [21]. Besides, the low cost, simple and reproducible fabrication process of the presented substrates result in homogenous substrates with a very high sensitivity for a wide range of molecules and medicines [19-22].

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Figures

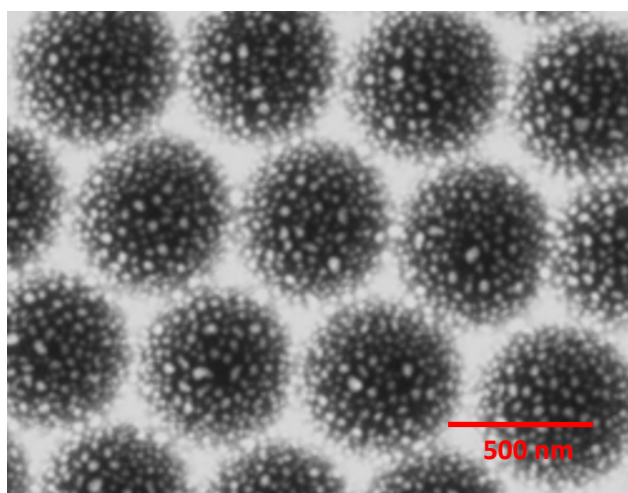


Figure 1. FESEM top view image of the developed SERS substrate for the detection of antibiotics.