The synthesis of silver nano-wedges decorated substrates for the detection of molecular traces by Surface Enhanced Raman Spectroscopy

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Abstract
Surface enhanced Raman spectroscopy (SERS) is a highly sensitive technique that allows detecting analytes at low concentrations [1, 2]. However, it remains challenging to perform SERS-based detection of target molecules in aqueous solutions, even more at nanomolar (nM) or picomolar (pM) concentrations. For this reason, there is a need to develop new methodologies for the preparation of substrates that exhibit high SERS effect. Such substrates should have a high-curvature features leading to the high content in ''hot spots'' which can facilitate the detection of molecular traces. In this work we demonstrate the preparation of ordered silver nano-wedges array fabricated by chemical reduction of silver ions on hydrofluoric acid etched silicon wafers. Given that the surface morphology is determined by the several factors such as reagents concentrations or substrate exposure time in/over the reaction solution, we optimized the synthesis conditions in order to prepare SERS substrates with ordered structure of silver nano-wedges. The characterization of prepared SERS substrates was carried out using Atomic Force microscopy (AFM), Scanning Electron Microscopy (SEM) and UV-vis spectroscopy. The theoretical model of electromagnetic field distribution on the substrate surface was performed using COMSOL software. The enhancement effect of Raman scattering for single molecule was tested by evaporating monolayer of pentacene (2 nm) on bare silicon wafer and SERS substrate. The enhancement factor was found to be 10^5.
Silver nano-wedges decorated SERS substrates were successfully applied for the detection of proteins and peptides in liquid at nanomolar concentrations. Therefore, this work is a significant step towards detecting biological targets in their natural environment as well as understanding their behavior at bio-nano interface. This work was funded by the European Social Fund under the Global Grant measure. Grant No. VP1-3.1-ŠMM-07-K-03-044.

References

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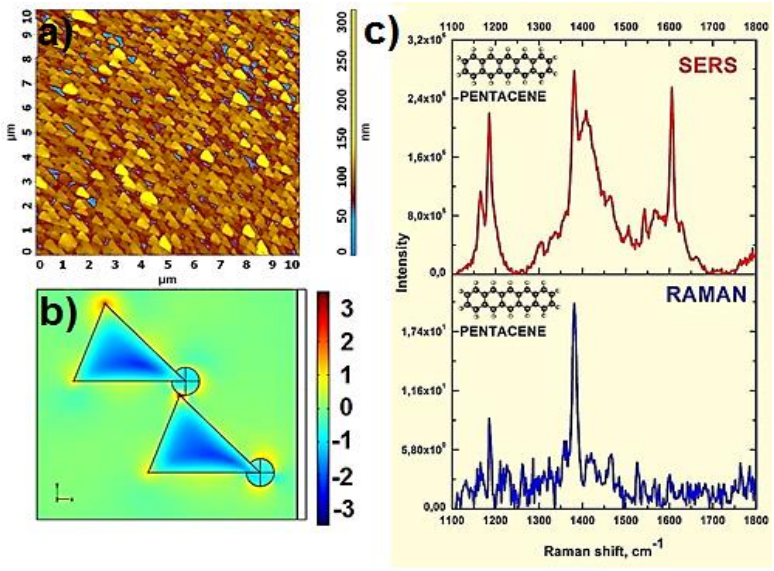

Figure 1. Silver nano-wedges decorated SERS substrate: a) AFM height image; b) theoretical model of electromagnetic field distribution of double wedge with a 5 nm gap: Log10(|E|^2/|E0|^2) in the X-Y plane at z= 50 nm; c) Raman and SERS measurements of pentacene monolayer evaporated on bare silicon wafer and SERS substrate.