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(2019PHZ8678)

Title: DEVELOPMENT OF 2D MATERIALS AND METAL NANOPARTICLES NANOCOMPOSITES FOR SERS BASED SENSING OF HAZARDOUS BIOMOLECULES AND DISEASES DETECTION VIA GLAD BASED Ag NANORODS

Abstract: The term sensing invokes curiosity in the entire scientific community as it plays a crucial role in every field. It involves sensing the presence of different biomolecules, infectious bacteria, explosives, toxic pollutants, poisonous gases and many other hazardous or non-hazardous components through various techniques. This study aims to develop and explore the 2D material and their nanocomposites with metal nanostructures for SERS applications along with real world application of SERS by employing silver (Ag) nanorods for distinction between different stages of oral cancer. In the first work, different morphologies of MoS2 were synthesized for potential SERS applications. The morphology tunability was achieved by varying the growth parameters during the facile solvothermal method. The MoS_2-Ag nanocomposite SERS substrates successfully detect an ultralow concentration of 10^{-15} M of RhB dye with an enhancement factor of 9.2×10^7. In next work, vertically oriented tungsten disulfide (WS_2) nanoflakes were synthesized on a silicon (Si) substrate using the pulsed laser deposition (PLD) technique. The fabricated nanoflakes of WS_2 were decorated with Ag NPs by employing thermal evaporation to enhance their SERS activity. The detection limits achieved for RhB and MO are 10^{-16} and 10^{-17} M, respectively with 532 nm excitation laser, and 10^{-13} M is the detection limit for MB dye with 633 nm laser. The promising enhancement factors of the order of 10^8 were achieved for WS_2-Ag nanocomposite substrate. In the following work, MoS_2-Au nanocomposite is fabricated for SERS application with optimized concentration of Au nanoparticles. The nanocomposites of MoS_2 and Au NPs are successfully used as highly sensitive SERS substrates for the detection of hazardous dyes RhB and N719, and infectious bacteria of E. coli and S. aureus. The MoS2-Au nanocomposite SERS substrate successfully detects the RhB and N719 dye up to 10-15 and 10-9 M. The highest enhancement factor obtained for RhB and N719 dye is 5.2 × 107 and 2.1 × 107, respectively. Further, the nanocomposite substrate was employed for the sensing of infectious S. aureus and E. coli bacteria down to 102 cfu/ml.

In the final work of this thesis, glancing angle deposition-based label free Ag nanorods were employed for diagnosis of oral cancer in its pre-malignant phases, prior to its development into malignant tumors. The SERS spectra of pre-malignant and malignant samples exhibited distinct peaks corresponding to varying concentrations of inorganic metabolites and proteins. The multivariate analysis successfully separates the oral cancer positive and negative samples, as well as pre-malignant and malignant groups.