Evaluating the SERS sensing properties of electrodeposited nanostructured Cu2O/Cu metasurfaces

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Abstract

Metal oxide semiconductor metasurfaces find myriad applications in photonics. Cu_2O is a semiconductor with its applicability in SERS underexplored. We report the utilization of electrodeposited nanostructured Cu_2O/Cu metasurfaces for SERS sensing. Nanostructured Cu_2O thin films were electrodeposited in an acetate bath and subsequently partially reduced to Cu through chemical reduction. Scanning electron micrographs revealed nanostructures with size scales up to 800 nm. Finite difference time domain simulations revealed the emergence of plasmonic hotspots between these nanostructures, which were significantly enhanced in the presence of electromagnetic excitations around 700 nm. These plasmonic hotspots were at least 100 times more intense compared to the incoming local electric field intensity. Quantitative SERS measurements at 785 nm laser excitation, and in the presence of methylene blue reported an enhancement factor of 10^4 and a lower detection limit of 100 ppb. These Cu_2O/Cu metasurfaces were also sensitive to the Raman reporter 5,5′-dithiobis-2-nitrobenzoic acid with a lower detection limit of 10 ppm. In summary, our work demonstrates the potential of engineering nanostructured Cu_2O/Cu metasurfaces for semiconductor-based SERS applications.