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Fabrication and optical characterization of reduced graphene oxide/silver nanoparticle hybrid structures for near-infrared photodetection

Abstract: Surface plasmons (SPs) of metallic silver nanoparticles (AgNPs) were investigated in hybrid structures of thin-film reduced graphene oxide (rGO) for light-sensing applications. The near-infrared (NIR) detection of the hybridized structures was demonstrated in two different device configurations. The first one was obtained by spin-coating of the rGO suspended in deionized water on top of the AgNPs layer that was predeposited on a transparent substrate, making rGO-top/AgNPs films. The second configuration was achieved by depositing AgNPs on top of the rGO film, yielding AgNPs-top/rGO films. Then, the conductive silver epoxy was applied at the corners of the films providing electrical contacts for further electrical characterizations. The measured photoresponse of these devices was studied at ambient temperature for different sizes and geometries of the AgNPs, under a focused beam of the NIR laser (lambda = 975 nm). We found a significant increase of the photocurrent in the rGO-top configuration with a large size of AgNPs (diameter = 200 nm) possessing 70% light transmission of the film. The increase of the photocurrent in this configuration was higher than that obtained in the pristine rGO, the triangular shape of the Ag nanoplates, and the smaller diameter of the AgNPs (30 nm). This observation indicated the local electric field produced by the larger size of the AgNPs that resulted in the stronger localized SPs resonance between the AgNPs and the rGO film. Our results agreed well with a computational simulation using finite-element analysis. This study provides a possible pathway of light confinement over rGO films using AgNPs for large-scale fabrication on transparent and flexible substrates.
Keywords: Surface Plasmons, Reduced-Graphene Oxide, Silver Nanoparticles, Hybrid Nanostructures, Near-Infrared Photodetector

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