Plasmonic Nanoparticle-Filled Elastic Nanopillar Arrays for Sensing Application

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Chameleon skin contains a lattice of guanine nanocrystals, the spacing of which can be tuned to create different colors in response to the environment. Inspired by chameleons, the goal of this research was to fabricate flexible, nanostructured nanoparticle-polymer composites and study the effects of strain on absorption spectra for sensing applications. This research synergistically combines two mechanisms for creating novel optical properties: chameleon-inspired nanopillar arrays and plasmonic nanoparticles. To precisely fabricate the nanopillar arrays, two-photon polymerization processes were optimized. Processes for mixing Ag nanocubes in uncured flexible polymer were then developed using a combination of centrifugal and magnetic mixing. A stretching apparatus was also designed to fit inside a spectrometer for spectra measurements of samples with various strains. After nanopillar fabrication, a scanning electron microscope was used to obtain pillar dimensions. The optical properties of the samples were measured at various strains using a UV-spectrometer. A model was created using JMP software to establish the relationship between the strain of the sample and the absorption spectra. As expected, strain resulted in a peak shift for samples with nanopillars, samples with nanoparticles, and their combinations. Interesting optical interaction between the nanostructures and nanoparticles was observed. This study has applications in colorimetric strain sensing and molecular sensing, both of which can be used for cell development monitoring and other cutting-edge applications in many fields.

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