Coupled Planar-Localized Surface Plasmon Resonance Device by Block-Copolymer and Nanoimprint Lithography Fabrication Methods

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Surface plasmon resonances (SPRs) are excited when light is incident upon a metal-dielectric interface, resulting in electric field oscillations that propagate along the interface. These electric fields have been shown to enhance light absorption as well as increased emission from materials that reside within the oscillating field. This phenomenon is exploited in chemical and biological sensing, in applications such as fluorescence and Raman scattering[1]. Furthermore, localized surface plasmon resonances (LSPRs) are localized oscillating electric fields resulting from light incident upon metal nanoparticles. These localized fields have an even greater and locally concentrated surface plasmon enhancement effect[2]. This report investigates the effects of coupling surface plasmon resonances (SPRs) and localized surface plasmon resonances (LSPRs) on the same device.

Au nanoparticles of less than 50 nm in diameter are fabricated via three methods as a platform for LSPR. First, silicon templates made from diblock copolymer patterns were used to imprint nanohole arrays into which Au was evaporated[3]. The resulting Au nanodots are shown in the SEM image in Figure 1a. Second, gold nanoparticles from a colloid solution were spin-casted onto the substrate. Finally, a Au thin film (< 5 nm) was evaporated and annealed to form Au nanoparticles. To achieve planar surface plasmons, an Al submicron grating with 150 nm holes at 500 nm pitch (Figure 1b) was created via nanoimprint lithography directly over the Au nanodot array. The SPR grating layer was 50-60 nm in thickness. Schematics of the proposed SPR-LSPR coupled plasmonic device are shown in Figures 1c and 1d.

The reflectance spectrum of the Al submicron grating is shown in Figure 2. The spectral features correspond to the plasmonic resonances of the device. We propose to collect reflectance spectra of the Au nanodots generated from the three different processes and expect to see similarly-featured spectra due to plasmonic effects. This report will further study the effect of coupling SPRs and LSPRs by observing the reflectance spectra of a prototype device that combines the submicron grating and nanodot features. The device will then be used to collect Raman scattering spectra of R6G molecules to observe the surface enhanced Raman scattering (SERS) effect. The coupled SPR and LSPR device is predicted to exhibit SERS spectral peaks greater than either the SPR or LSPR device alone.

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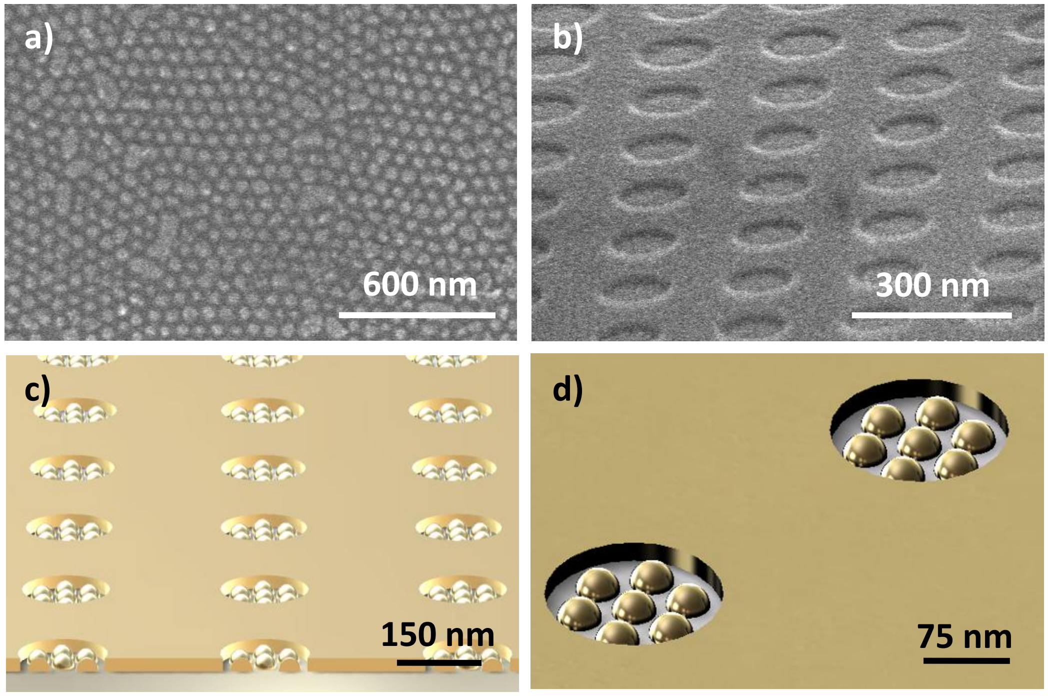

Figure 1: Scanning electron images of a) Au nanodot array b) Al submicron grating. c) and d) Schematics of the coupled SPR and LSPR device consisting of Au nanodots in the holes of an aluminum submicron grating.

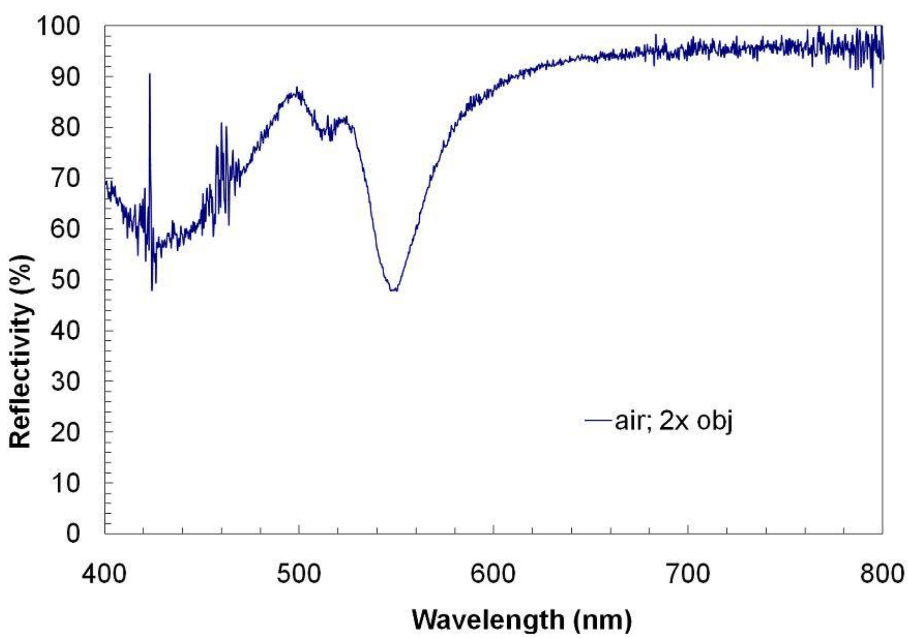

Figure 2: Reflectivity spectra of a 60 nm-thick aluminum submicron grating.