

Dissecting the optical resonances in arrays of metal-coated Si nanopillars

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Our research group has previously reported on the strong surface enhanced Raman scattering (SERS) response detected from Si nanopillar arrays overcoated with Au and Ag via ebeam evaporation, and Ag via plasma-enhanced atomic layer deposition (PEALD). These structures demonstrated enhancement factors in excess of 10^8 for widely spaced nanopillar arrays, and a further 1-2 orders of magnitude increase for arrays with gaps of $< 2\text{nm}$ using Ag PEALD, with very little spatial deviation over the arrays and a high density of 'hot-spots' which enables short acquisition times (0.1 – 5s). To elucidate the strong ($\sim 10^8$) and uniform SERS response of these systems, we have measured their bright- and dark-field reflection spectra, from 0.4 to $3\text{ }\mu\text{m}$, in three different geometries: 1) bare Si nanopillars; 2) nanopillars topped with Au caps; 3) pillars with both Au caps and a film on the substrate. We dissect the complex spectra into dielectric cavity and local and traveling-wave plasmonic modes. Computer modeling indicates that the incident irradiation is redirected in an orthogonal direction within the array with strong confinement observed within the Si pillars and at the metal surfaces. For the dielectric cavities in the absence of a plasmonic metal, the strong confinement within the Si induces a strong enhancement of the Si Raman line and a large absorption of the incident when the cavity resonance coincides with the incident wavelength. The dependence of the various resonant modes observed upon variations in the metal type, diameter, pitch and periodicity will be discussed in detail.

Biography

Francisco Bezares completed his undergraduate studies in physics at the University of Puerto Rico in 1996. After several years of active duty military service, he graduated from UMass, Boston with an M.S. degree in Applied Physics in 2004 and a Ph.D. in Physics from Temple University in 2009. He has received several awards throughout his academic and professional career that include the Temple University Future Faculty Fellowship Award, the Peter Havas Scholarship Award as well as several industrial performance and military awards. Mr. Bezares is currently a postdoctoral researcher at the Naval Research Laboratory.

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