Plasmonic devices for high sensitivity Raman spectroscopy

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Tuning the properties of light at the interface between a metal and a dielectric is a significant emerging topic known as plasmonics. The strong interactions between the electromagnetic field of light and the mobile electrons of the metal, induces a collective oscillation of the electron-waves that propagates along the interface. This phenomenon is called surface plasmon. By designing a suitable metal-dielectric interface, it is possible to manipulate the frequency and the intensity of the electromagnetic waves. This effect could be applied in the area of optoelectronics, more specifically in the fabrication of nanoprocessors, the development of microscopes with higher spatial resolution, as well as in the design of extremely sensitive sensors for single molecule detection.

In this context, one of the goals in our group is to design and fabricate plasmonic devices that can be used in conjunction with surface enhanced Raman spectroscopy to enhance the signal of low concentration systems, such as monolayers or single molecules. An array of gold nanostructures on glass (fig. a) was fabricated by electron beam lithography at *The Western Nanofabrication Facility*. First, clean glass slides were spin coated with a positive photoresist (ZEP 520). Then a 20 nm chromiunm layer was deposited with a Magnetron sputtering tool under an Argon plasma. The next step was to write the patterns using a LEO 1530 Field Emission scanning electron microscopy (SEM). After this, samples were chromium etched, the underlying photoresist was developed, and a gold layer was deposited by e-beam evaporation. Finally, after deep UV treatment of the photoresist, a lift off process was used to remove the remnant photoresist and to obtain the desirable patterns. This lithographic technique allows full control of the design geometry with a high reproducibility and excellent resolution.

We have demonstrated that it is possible to improve the Raman sensitivity of a monolayer of azobenzene molecules adsorbed on these plasmonic devices by 3 to 8 orders of magnitude, thus reducing acquisition time and laser irradiance (fig. b). Finally, in order to get a better understanding of the plasmonic effect of these nanostructures, we are performing some finite-difference time-domain (FDTD) computational studies (fig. c).

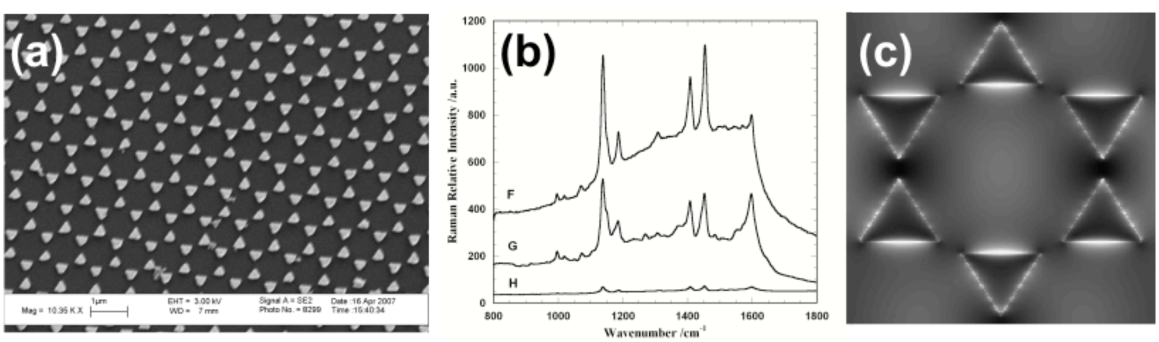

Figure (a) Plasmonic device made of gold triangles on a glass substrate fabricated at *The Nanofabrication Facility*. The triangles lengths are 200 nm. (b) Raman spectra of a monolayer of azobenzene molecules adsorbed on the nanostructured surface. The most intense spectrum was obtained when the input laser light matched the frequency of the plasmonic device. (c) Total electric field calculation of the same triangular gold array shown in fig. (a). The bright spots represent the areas with highest intensity of the electric field.

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