Defense Announcement

PLASMONIC NANOSENSORS FOR IMPROVING THE SENSITIVITY OF SURFACE ENHANCED RAMAN SPECTROSCOPY

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Location: ECE Large Conference Room

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Over the past four decades, the development of advanced techniques for fabricating metallic nanostructures has reinvigorated interest in using surface-enhanced Raman spectroscopy (SERS) for practical applications in molecular sensing and chemical compositional analysis. Although numerous SERS substrates have been reported, most lack the reproducibility, structural uniformity, high density of strong field regions-*hot spots,* large active area, and low cost required for applications. In this work, SERS substrates that address these issues are developed and characterized.

One of the earliest and simplest SERS substrate was evaporated Au/Ag nano-islands on glass substrates. However, the adhesion of these nano-islands is poor, particularly in aqueous environments. We showed that the use of sputter-deposition, instead of evaporation, provides reliable adhesion and, additionally, a practical way to control nucleation and film growth. By optimizing process conditions, we were able to induce nano-gaps in the films, which are known to be associated with a strong SERS response. In this work, through correlation between the process conditions, film morphology and SERS response, we have been able to obtain enhancement factors (EF) of $5 * 10^6$, 5 times higher than the best evaporated films.

More recently, nanoporous gold (NPG), a bicontinuous 3-D porous gold structure formed by free corrosion of Au/Ag alloys, has generated considerable interest as a SERS substrate. NPG features a high density of hot spots and a tunable plasmon resonance. The structural evolution of NPG/Au bilayer films and its effects on SERS intensity were studied in detail. By optimizing pore structure, we were able to increase EF by a factor of 6 over the state-of-the-art; a 75-fold increase was achieved by optimizing the gold-layer thickness. Patterning the NPG film into sub-wavelength disk shaped structures (NPGDs) produces EFs as high as $5.2 * 10^8$.

Finally, NPG and patterned gold sensors were formed on optical fiber substrates to explore plasmonics on optical fibers for remote sensing applications. In the first approach, NPG was deposited on fibers with cylindrical and tapered ends. In the second, periodic arrays of gold sensors were fabricated using ion beam proximity lithography, a high throughput approach where many fibers can be patterned simultaneously.