Project title: Nanoplasmonics and Surface Enhanced Raman Microscopy

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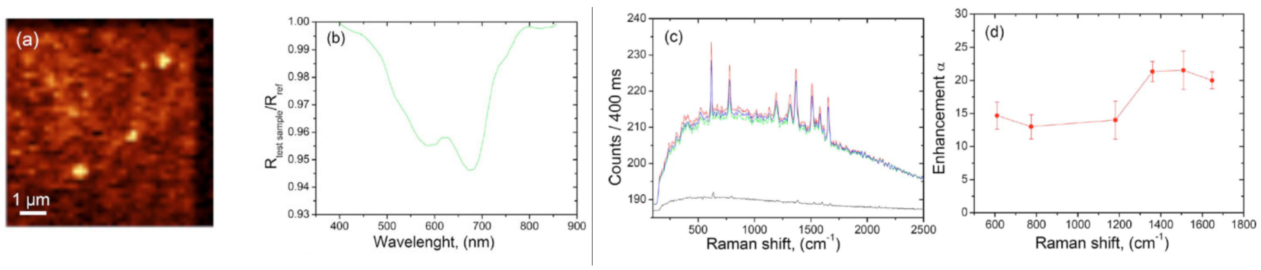
PROJECT DESCRIPTION:

Nanoplasmonic structures have attracted a lot of interest in recent years, including their ability to concentrate and amplify electromagnetic fields all the way down to nanoscale using so-called surface plasmon polaritons. These surface plasmons are collective fluctuations coupled between the emitted electromagnetic light and the conduction electrons in a metal nanoparticle or along a metal surface. By focusing and locating surface plasmons through nm-size metallic objects and, e.g., sharp grooves or well-organized groups of particles, extreme light concentrations down to nm-scale can be achieved. Such concentrated and amplified electromagnetic fields can be used for Surface Enhanced Raman Spectroscopy (SERS) on various molecules adsorbed to the metal structure, which is particularly interesting as Raman spectroscopy provides a kind of molecular fingerprinting through characterization of the vibrations in the chemical bonds, e.g., C-H, C-C, C-O, etc. Unfortunately, the Raman scattering process has a very weak signal compared to plain-scattered (Rayleigh) light.

The idea of the project is to utilize different configurations of metal nanostructures to achieve as much amplification as possible of the Raman signal from solutions with different relatively low concentration of molecules and to investigate the effect of plasmon resonances on the Raman spectrum.



Example of surface enhanced Raman microscopy (a), spectroscopy (c), reflection spectrum (b), and relative enhancement of the Raman peaks (d) for a structure with 100 nm diameter gold particles relative to a flat gold surface [1].

One should study the literature on what has been achieved so far and based on these ideas make suggestions for new designs, after which work is continued with some of the most promising and realizable configurations. Electron lithography and microscopy are used for the manufacture and characterization of the desired metal nanostructures. Optical reflection spectroscopy can be used to characterize the plasmon resonances in the nanostructures, followed by detailed microscopic studies of the Raman scattering from different molecules enhanced by the surface of the nanostructures. Possibly, atomic force microscopy (AFM) can be combined directly with the Raman characterizations.

[1] J. Beermann, S. M. Novikov, O. Albrektsen, M. G. Nielsen, and S. I. Bozhevolnyi, “Surface-enhanced Raman imaging of fractal shaped periodic metal nanostructures”, *J. Opt. Soc. Am. B.,* **26**: 2370 (2009).