



Scalable Nanomanufacturing Route for Plasmonic and Metasurfaces

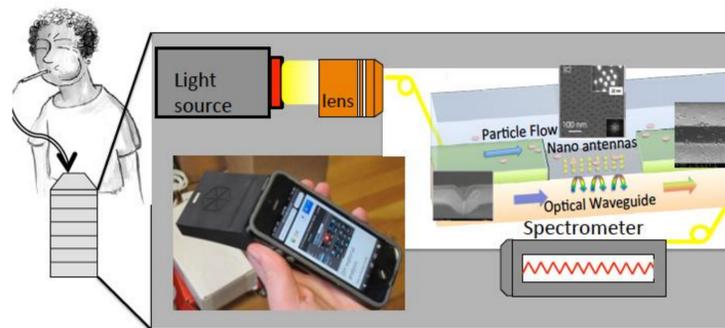
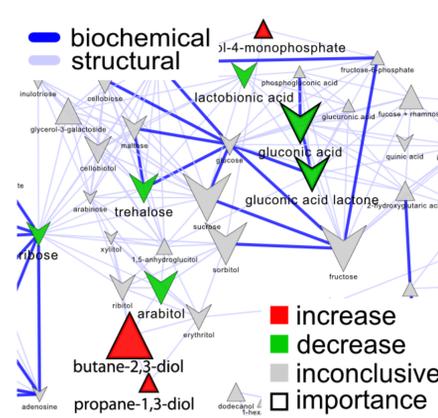


W. Thrift, M. Darvishzadeh-Varcheie, Q. Zhao, M. Kamandi N. Sharac, S. Campione, K. Whiteson, C. Guclu, M. Madou, O. Boyraz, F. Capolino, Regina Ragan

Motivation

Metabolites in breath and saliva samples are biomarkers for lung infections that reduce the life span of cystic fibrosis and COPD patients. Need low cost method to measure metabolite signals at parts per billion levels to monitor these chronic infections.

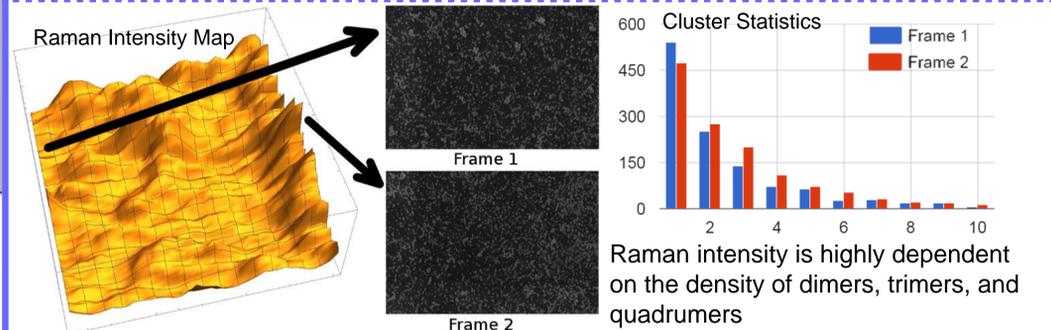
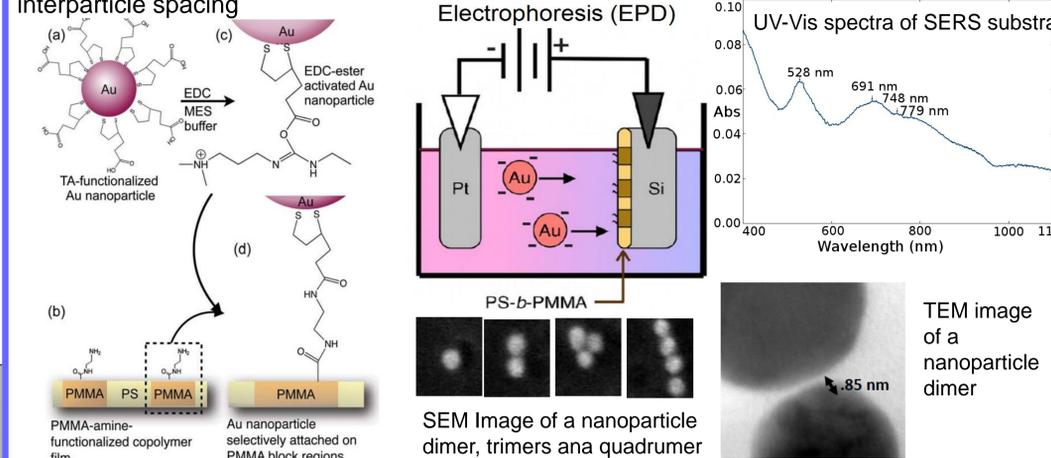
Whiteson KL., et al. (2014) The ISME journal 8: 1247.



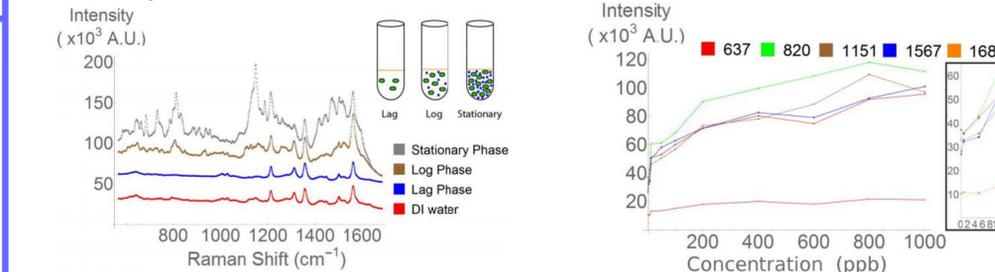
Schematic of chip with nanostructured surface integrated with compact commercial spectrometer and laser light source for ease of use. Integrated CMOS compatible waveguides for light guiding and characterization of nanostructured surface to enhance optical signals to sufficient levels to detect metabolites at relevant levels.

Fabrication of Low Cost and Robust Sensor Surfaces

EDC/s-NHS cross linking chemistry is used in order to chemically attach the gold nanoparticles (with lipoic acid) to the PMMA domains (functionalized with ethylenediamine) on diblock copolymer. Electrophoresis is used to enhance nanoparticle density and reduce interparticle spacing

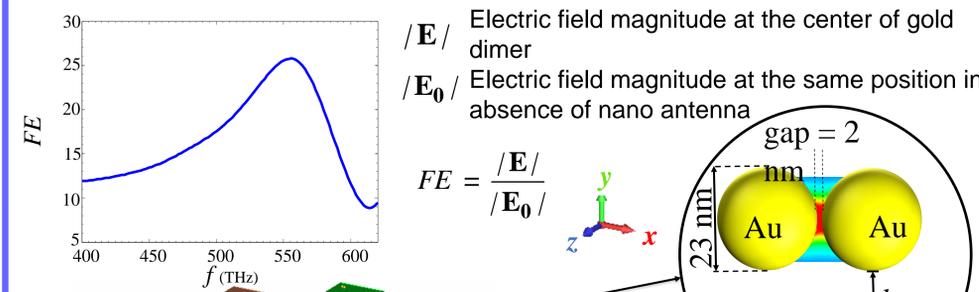


Self-assembled gold nanoparticle cluster SERS substrates are highly uniform, with Raman signal variances as low as 17% over >100µm² areas



Growth phases of *Pseudomonas Aeruginosa* (left) were determined by tracking the concentration of its quorum sensing compound pyocyanin using the sensors which were determined to have a limit of detection of 10ppb (right) for pyocyanin

Field enhancement with Plasmonic Nanoantenna by Silicon Nitride Waveguide

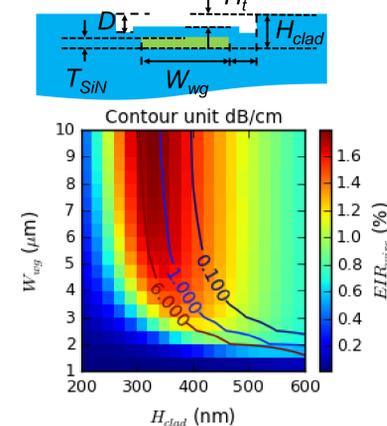


Nano antennas on top of silicon nitride waveguide are excited by the first guided mode in waveguide. Electric field is strong at the gap.

SiN Buried Shallow Trench Waveguide

Silicon nitride trench waveguide based on anisotropic etching show large nonlinearity which can be further enhanced by depositing gold nanoparticles and clusters in the trench region

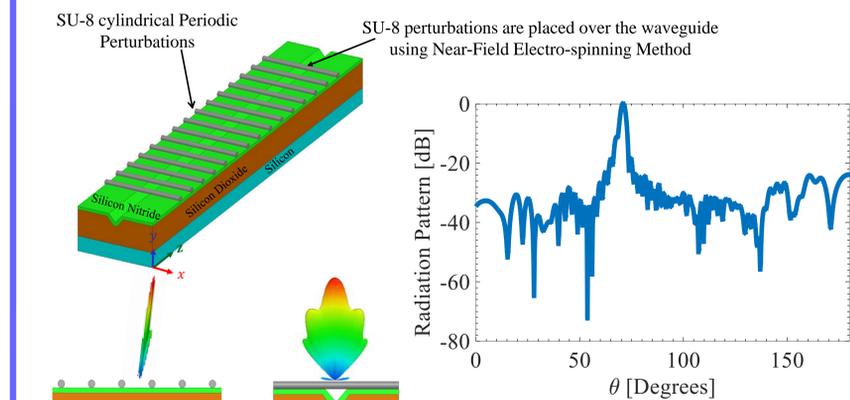
New waveguides with shallow trench are also designed to suspended wire-light interaction



EIR as a function of waveguide geometry

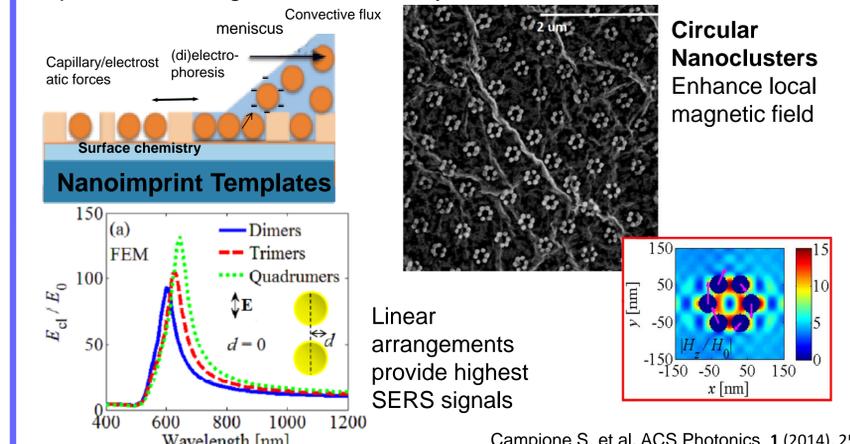
Electromechanical Leaky-Wave Antenna

Optical Leaky-wave antenna (OLWA) is a highly-directive optical antenna that has its radiation principle based on the excitation of a leaky-wave.



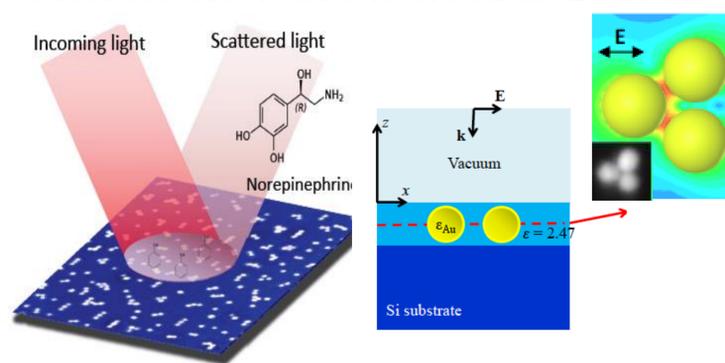
Scalable Metasurface Fabrication

Nanoimprint templates will be used to improve uniformity of SERS sensor response and design new functionality.

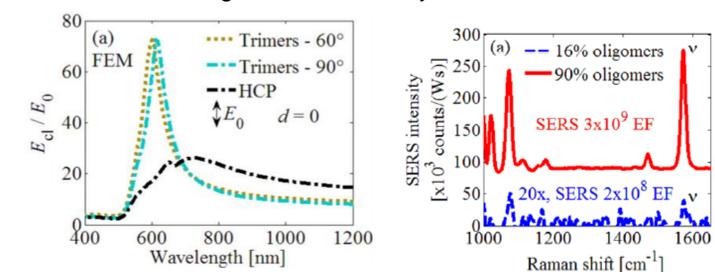


Linear arrangements provide highest SERS signals

Surface Enhanced Raman Scattering Sensors for Trace Molecular Detection



Surface enhanced Raman spectroscopy (SERS) utilizes the electric field enhancement between nanoparticles in order to increase the number of scattering events with analyte



Our work shows plasmonic "hot spots" can be engineered to achieve billion fold SERS enhancements using discrete gold nanoparticle clusters. These have higher enhancements (EF) than continuous hcp structures.