

# Nanohour

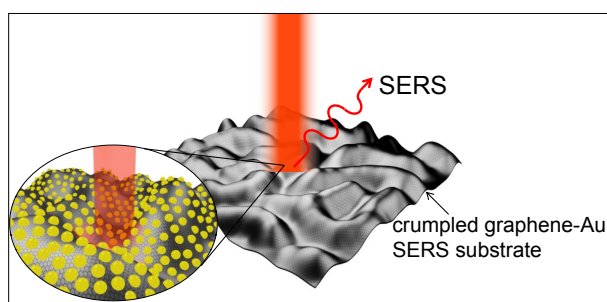
Wednesday, May 6, 2015, 3:00 pm  
Beckman Institute – Room 4269

## Three dimensional Graphene-Gold Nanoparticle Hybrid Structure for Surface Enhanced Raman Spectroscopy

Juyoung Leem, Mechanical Science and Engineering

Graduate student with Professor SungWoo Nam

Graphene is a two dimensional (2D)  $sp^2$  bonded carbon crystal with delocalized  $\pi$  electrons contributing to surface enhanced Raman scattering (SERS) in a way of chemical mechanism (CM) [1]. Furthermore, orders-of-magnitude stronger Raman enhancement has been achieved by a hybrid structure of gold nanoparticles (Au NPs) decorated with a flat graphene layer [2] due to electromagnetic (EM) field enhancement of Au NPs. To further improve SERS of graphene-Au hybrid structures by introducing three-dimensionality, we propose a three-dimensional (3D) SERS platform based on crumpled graphene structure decorated with Au NPs. First, we demonstrate controlling of the decoration of Au NPs on graphene surfaces with



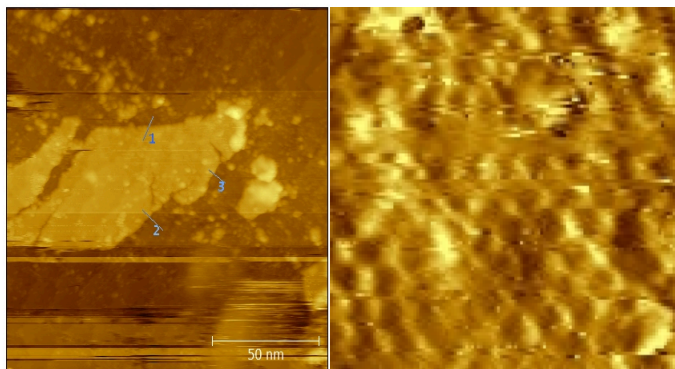
tunable NP sizes and thus plasmonic resonance wavelengths. Second, we induce controlled crumpling of graphene-Au NPs hybrid structures to generate 3D textured surfaces with enhanced CM and EM field enhancement. We finally investigate SERS enhancement effects of our 3D graphene-Au NPs hybrid structures by using several key Raman active molecules. We believe our new 3D graphene-Au NP hybrid platform will provide new and enhanced SERS detection capabilities of small molecules for advanced biomedical diagnostics in the future.

## Synthesis of 1T-Tantalum Disulfide and Direct Observation of Charge Density Wave

Sundaravadiivel Rajarajan, Electrical and Computer Engineering

Graduate student with Professor Joseph Lyding

Over the past decade, due to the increasing interest and urgency in finding an alternate material system for post-silicon logic and opto-electronic applications, staggering progress have been made in the study of low-dimensional materials. These low-dimensional materials not only help reduce transistor footprint and improve power and performance metrics, they also exhibit very peculiar electrical properties. A particular example is the existence of a charge density wave (CDW) in 1T-Tantalum (IV) Sulfide (1T-TaS<sub>2</sub>). A member of the transition metal dichalcogenide (TMDC) family, 1T-TaS<sub>2</sub> exhibits a periodic modulation of electronic charge density. Unlike bulk semiconductor or metals, lattice distortion in this low-dimensional material creates non-uniform, “wave-like” electron densities. We have developed two bulk-growth strategies for the synthesis of 1T-TaS<sub>2</sub>. We have successfully grown poly-crystalline 1T-TaS<sub>2</sub> powder through a direct solid-solid reaction and single-crystals of 1T-TaS<sub>2</sub> through Iodine-assisted chemical vapor transport (CVT). Next, we performed an ultra-high vacuum scanning tunneling microscopy (UHV-STM) study of the grown poly-crystalline 1T-TaS<sub>2</sub>. The powder was deposited onto an atomically flat, H-passivated silicon substrate using dry contact transfer (DCT), an *in-situ* deposition technique developed by the Lyding group for clean, UHV-compatible transfer of nano-materials. We managed to directly observe room-temperature CDW on the deposited nano-flakes of 1T-TaS<sub>2</sub>. The periodicity of the CDW lattice corresponds very closely to the expected  $\sqrt{13} \times \sqrt{13}$  nearly commensurate room-temperature CDW phase.



Coffee and cookies will be served

<http://nanohour.beckman.illinois.edu/Nanohour/Nanohour.html>