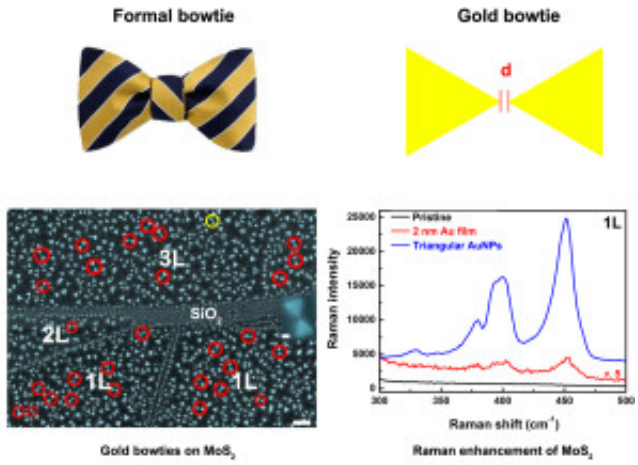
Gold "bowtie" coming into reality on two-dimensional MoS2 surface

"Bowtie'', which is a type of necktie, is very popular in our daily life. In some formal meetings or parties, bowtie is the normal choice to make you look good. Actually, this kind of bowtie structures of interesting materials are also potentially attractive in many research fields like in cancer hyperthermia, optical imaging and surface-enhanced Raman scattering (SERS), etc. The most popular ones are gold or silver bowties for molecular detection by surface-enhanced Raman scattering.



Raman scattering is a spectroscopic analysis on the vibration between the atoms of a molecule, while surface-enhanced Raman scattering involves the enhancement of the spectral signal of a molecule on a metal (Au or Ag) surface with a magnitude up to six orders. To make this enhancement even larger, metals having a rough surface or sharp tips, or a nanometer gap between two tips are needed. So many scientists in this field are designing and making unique metal nanostructures for molecular detection. A gold bowtie is composed of two opposite nanotriangles facing tip to tip with a nanometer gap. So once a laser spot or light is irradiated on the tip, there is a great enhancement on the light signal at these tips or sharp edges. At present, most of gold bowtie structures are prepared by electron beam lithography, which is expensive and difficult to make. So it is necessary to find a simpler route to achieve this goal. To this end, Dr. Haiqing Zhou in Prof. Zhifeng Ren's group at University of Houston in USA and Prof. Lianfeng Sun's group in the National Center for Nanoscience and Technology of China studied a template-assisted growth to grow gold bowties on top of MoS_2, which is a convenient and cost-effective route compared to the lithographic techniques. Experimentally, they found the growth and anisotropic etching of MoS_2 single crystals usually exhibit triangular shapes, meaning these triangular structures of MoS_2 are thermodynamically stable. Accordingly, using few-layer MoS_2 as the growth template, they made gold bowtie structures with a large density. Furthermore, a detailed characterization observed that the gap spacing between two nanotriangles can be as small as 3

nm (the smallest gap ever reported), which resulted in great enhancements on the Raman signals of the underlying MoS_2 substrate, indicating their potential use in surface-enhanced Raman scattering. The enhancement factors depend on the spacing gap: The smaller the gap is, the stronger the enhancement is (up to 10^{12}).

Publication

Well-oriented epitaxial gold nanotriangles and bowties on MoS2 for surface-enhanced Raman scattering.
Zhou H, Yu F, Guo CF, Wang Z, Lan Y, Wang G, Fang Z, Liu Y, Chen S, Sun L, Ren Z.
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