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Nano-scale Tunable Surface Enhanced Raman "Hot-Spots" for Nanobio Sensing

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The strong localized electromagnetic field near the metal nanoparticles at plasmon resonance makes them appealing for Surface Enhanced Raman Scattering (SERS). Recent experiments have shown that the effective cross sections of Raman scattering can reach a comparable level to that of fluorescence of bio-labeling dyes, making SERS a potential single-molecular detection tool. However, the commonly used substrates for SERS consist of colloidal Ag/Au particle aggregates, where SERS active sites, called "hot spots", are only found by chance and not controllable.

In order to engineer the desired resonance wavelength and field strength, it is important to establish the energy transfer in coupled metallic nanoparticles. In this paper, we will review experimental and theoretical studies on the plasmon resonances of a set of nanoparticles fabricated with precise position, spacing and size. We will further demonstrate a new design of alternating Au/SiO_2 layered composite nano particles, called nanoburgers. The new designed nanostructure exhibits several distinctive properties such as large red-shift plasmon resonance wavelength and stronger localized electromagnetic field. The large tuning red-shift of plasmon wavelength provides more freedom of choosing excitation laser for SERS, and the stronger local field promise to achieve SERS sensitivity towards single molecule level detection. Another important merit of the nanoburger particles is that they can be fabricated with traditional micro/nano lithography techniques, and thus are integratable with techniques such as lab-on-a-chip.