PLASMON ENHANCED TWO-PHOTON PROPERTIES AND THEIR APPLICATIONS

QING-HUA XU (徐清华), Department of Chemistry, National University of Singapore

Noble metal nanoparticles have been known to display many unique optical properties including surface plasmon resonance. Plasmon coupling arises when metal nanoparticles come to close proximity, resulting in dramatically enhanced local electric field within the gap of coupled nanoparticles. The giant local field enhancement would result in significantly enhanced optical responses such as giant surface enhanced Raman scattering (SERS) and two-photon photoluminescence (TPPL). Metal nanoparticles of spherical shapes typically display weak TPPL because of their relatively small two-photon absorption cross section and low emission quantum yield. Our recent studies showed that addition of cationic conjugated polymers into Au and Ag nanoparticle solutions can induce aggregation of metal nanoparticles, which created hot spots with enhanced electric fields. Consequently coupled gold nanoparticles gave SERS enhancement factors of 8.4 $\times 10^9$, ~400 times stronger than isolated gold nanoparticles [1]. TTPL of Ag nanoparticles were found to be enhanced by ~50 times when Plasmon coupling was induced by addition of conjugated polymers [2]. Such plasmon coupling enhanced TPPL phenomenon was subsequently demonstrated in Au, Ag and Au/Ag alloy nanoparticles of different sizes and shapes [3]. We have further developed various platforms for two-photon sensing and imaging applications, such as detection of Hg^{2+}, cysteine, glutathione [4-5] and many other biologically important species. We have also conducted single particle spectroscopy studies on the coupled nanoclusters and TPPL enhancement of up to 10^5 were observed on the single particle level [6]. Ultrafast two-pulse emission modulation experiments have also been performed to investigate the underlying enhancement mechanisms [7].

References

1. L. Polavarapu and Q.-H. Xu, *Langmuir*, **2008**, 24, 10608.
2. Z.P. Guan, L. Polavarapu, Q.-H. Xu, *Langmuir*, **2010**, 26, 18020.
3. F. Han, Z.P. Guan, T.S. Tan, Q.-H. Xu, *ACS Appl. Mater. & Interf*, **2012**, 4, 4746.
4. C.F. Jiang, Z.P. Guan, S.Y.R. Lim, L. Polavarapu, Q.-H. Xu, *Nanoscale*, **2011**, 3, 3316.
5. Z.P. Guan, S. Li, P.B. Cheng, N. Zhou, N.Y. Gao, Q.-H. Xu, ACS Appl. Mater. & Interf, **2012**, 4, 5711.
6. Z.P. Guan, N.Y. Gao, X.-F. Jiang, P.Y. Yuan, F. Han, Q.-H. Xu, J. Am. Chem. Soc. **2013,** *135* (19), 7272.
7. X.-F. Jiang, Y.L. Pan, C.F. Jiang, T.T. Zhao, P.Y. Yuan, T. Venkatesan, and Q.-H. Xu, J. Phys. Chem. Lett. **2013**, 4, 1634.