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Plasmon Enhanced Nonlinear Optical Properties and Their Applications

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Abstract. Noble metal nanoparticles, such as gold (Au) and silver (Ag), display unique properties known as localized surface Plasmon resonance, which could be utilized to enhance linear and nonlinear optical properties of nearby chromophores and metal nanoparticles themselves. In this talk, I will present our group's efforts on plasmon enhanced one- and two-photon excitation fluorescence and their applications. In particular, we found an interesting phenomenon that originally nonfluorescent metal nanoparticles emit strong two-photon photoluminescence (2PPL) upon plasmon coupling in the aggregated state. We have demonstrated that this kind of plasmon coupling enhanced 2PPL is a general phenomenon for Au and Ag nanoparticles of different morphologies. 2PPL of these metal nanoparticles was found enhanced by >800-fold in the colloid solution and five orders of magnitude on single particle level upon plasmon coupling. As many biologically important species can cause aggregation of metal nanoparticles, this phenomenon has been further utilized to develop various two-photon sensing and imaging applications to take their unique advantages of deep penetration into biological tissues and 3-dimensional confined excitation. We have also employed ultrafast spectroscopy and single particle spectroscopy to understand the underlying enhancement mechanisms.

Biographical sketch. XU Qing-Hua (徐清华) received his B.S. from Zhejiang University (1993), M.S. from Peking University (1996) and University of Chicago (1997), Ph.D. from UC Berkeley (2001), and conducted the postdoctoral research at Stanford University and UC Santa Barbara. He joined NUS Chemistry in 2005 and became an Associate Professor since 2011. His primary research interest is development of various light based applications such as sensing, imaging, photosensitization and optoelectronics using various nanomaterials and organic/polymer materials, as well as investigation of the underlying fundamental mechanisms using various novel optical spectroscopy and imaging techniques. So far he has published >180 peer reviewed articles with citations of >6000 times and H-index of 47.

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