Deciphering the impact of Energy Transfer Mechanisms on Third Order Nonlinearity of Plasmonic-Organic Hybrids

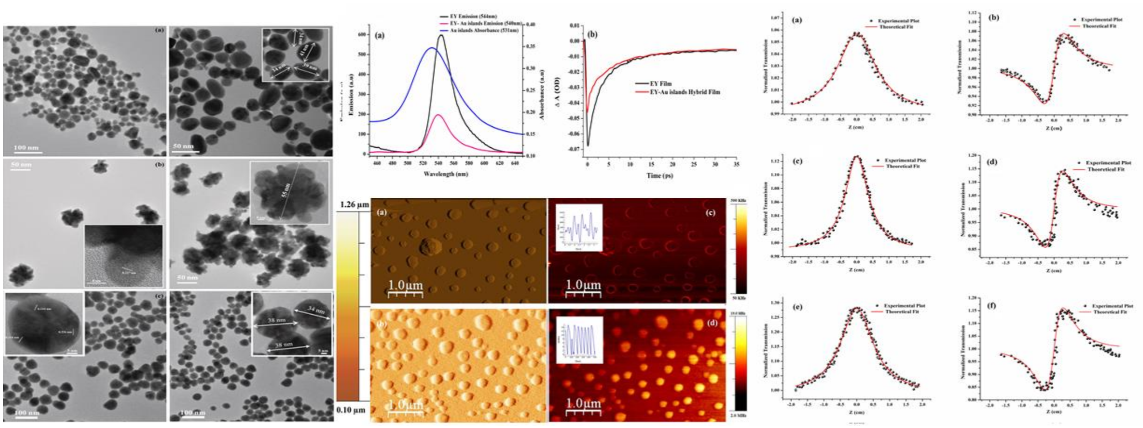
Kaweri Gambhir[1, 2*], Parag Sharma[1, 2] and Ranjana Mehrotra[1, 2]

[1]*Academy of Scientific & Innovative Research (AcSIR), CSIR-National Physical Laboratory Campus(CSIR-NPL), New Delhi -110012, India*

[2] Council of Scientific and Industrial Research,-*National Physical Laboratory, Dr. K.S. Krishnan Road, New Delhi-11012, India*

Author e-mail address: kawerigambhir@gmail.com

Abstract : A long-standing goal in optical sciences has been to strengthen nonlinear optical effects at lower light powers or pulse energies[1]. In this perspective, strongly-coupled hybrids which offer significant third order optical nonlinearities at low powers are currently a topic of global research[2,3]. Herein, we report a detailed analysis of third order nonlinear photonic characteristics of the fabricated nanohybrid system at moderate signal power. The far field and near field optical coupling between the constituents of the hybrid was investigated using Near field scanning optical microscopy and Raman spectroscopy respectively. While the optical nonlinearity (i.e. two photon absorption in this case) was studied using Z-scan spectroscopy. The experimental outcomes reveal that both in the linear and the nonlinear regime the dye and the gold nanocomposites represent a highly interacting system. A 400%, 120%, 32% and 39% enhancement in the two photon absorption coefficients of an organic dye Eosin Yellow is observed when hybridized with Au islands, gold nanoflowers, gold nanopebbles and gold nanospheres respectively. The results are explained in terms of the energy transfer from the dye to the hybridized nanostructures and substantiated using Ultrafast Sectroscopy. The investigations of such mechanisms and development of such approaches, may bring forth exciting advances, not only in terms of strongly interacting photons, but also cast new light on energy transfer mechanisms involved, which are of considerable importance and may lead to the first practical application enabled by these techniques.



Figures (Left to right): TEM micrographs (a) GNP (gold nanopebbles), (b) GNF (gold nanoflowers) (c) GNS (gold nanospheres). The inset shows the HR-TEM image of the gold nanostructures. 2) Energy transfer traces of the EY and EY-Au film 3.) Topographic analysis (AFM image and NSOM) of bare Au-islands and EY-Au islands hybrid, respectively. 4)Theoretical and experimental traces of (a,b) open and closed aperture Z-scan at 532 nm of Au islands sputtered on glass substrate. (c,d) open and closed aperture Z-scan spectra of EY-Au islands hybrid.

Refrences

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