

DAMOP13-2013-000375

Abstract for an Invited Paper  
for the DAMOP13 Meeting of  
the American Physical Society

### **Quantum dots-plasmonics nanostructure hybrid nanosensors**

ALI HATEF, Laser Processing and Plasmonics Laboratory in the Department of Engineering Physics, École Polytechnique de Montréal

Significant research efforts have focused on the investigation of fluorescent nanosensors for optical detection of single chemical and biological molecules with ultra-high sensitivities. The existing approaches for optical detection require the molecules to directly absorb the probe signal or to absorb light to produce fluorescence. These methods not only have their own problems, such as the background interference and scattering properties of the sample, but a common problem is that most molecules are purely refractive and non-absorbing. Recently, quantum dots (QDs)-based fluorescent sensors have attracted considerable interest due to the merits of high signal output and simplicity. This is largely due to the unique properties of QDs such as size-tunable photoluminescence (PL) emission colors, high quantum yields, photo stability and robust chemical stability. According to optical transduction schemes, some of these sensors exploit the Fluorescence Resonance Energy Transfer (FRET). Such an energy transfer mechanism occurs when the light energy absorbed by quantum dots (donor) is transferred to a nearby acceptor species, such as an organic fluorophore, another QD, or a metallic nanoparticle via non-radiative means. In this talk we introduce a new generation of nanosensors consisting of a QD and gold nanoparticle (AuNP) hybrid system connected by molecular springs such as double-stranded (ds) DNA. Primarily studies showed that FRET between QDs and AuNPs induced by a laser field (coherent exciton-plasmon coupling) supports a bistability in the SQD- AuNP hybrid system, referred to as bright and dark states based on photoluminescence enhancement and suppression of QDs. In the former case the strong local optical field due to the excitation of AuNPs' surface plasmon resonance act as an optical antenna by increasing the QD's excitation rate, and in the latter case, the AuNP quenches the QD's PL by introducing additional nonradiative channels next to PL. The balance between these two stable states can be controlled by the size, material type, geometry, QD-AuNP interparticle distance, wavelength of optical excitation of fluorescence and the local refractive index of the background materials.