Radiative Decay Engineering: The Use of Metallic Nano-Structures to Control Emission Properties of Fluorophores

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Fluorescence technology is the foundation of numerous analyses in sensing, medical diagnostics, biotechnology and gene expression. Recently we have reported new generic phenomena associated with metal-fluorophore interactions. Excited fluorophore near conducting metallic structures can efficiently couple to surface plasmons (electromagnetic surface excitations localized near the surface that originate from the free electrons of the metal). This coupling dramatically affects the emission properties. Theoretical predictions and experimental results demonstrate dramatic fluorescence signal enhancement and high directionality of the emission for fluorophores positioned close (up to 200 nm) to the metallic surfaces and nanostructures. We call this phenomena radiative decay engineering (RDE). The useful changes of spectral properties of fluorophore in proximity to conducting metallic surfaces/nanostructures include increased rates of excitation, increased quantum yields, decreased fluorescence lifetime with increased photostability, directional rather isotropic emission and drastically increased multi-photon excitation.

We recently demonstrated high potential of metal enhanced fluorescence for use in biological assays, immunoassays, and for studying biophysical properties of macromolecules.

Surface Plasmon-Coupled Emission: Ultra Sensitive Fluorescence Detection Technology

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Recently we have reported a fluorescence phenomenon that occurs at the interface of a dielectric and a thin metallic film. Excited fluorophores near continuous semi-transparent metal films can efficiently couple to surface plasmons and “emit” into the glass substrate behind the metal film at sharply defined angles. These remarkable properties are available from the near-field interactions of fluorophores with nearby semi-transparent planar metal surfaces. The metallic surface modifies the photonic mode density (PMD) near the fluorophores to result in highly polarized directional emission. The direction of coupled emission is highly sensitive to refractive index of dielectric medium, so it can be used for efficient detection of biochemical processes that result in localized surface density modification like ligand or biomolecule binding and/or conformational changes. This technology, which we call surface plasmon-coupled emission (SPCE), is in essence the reverse process of surface plasmon resonance (SPR) a technology used to measure bioaffinity reactions on the surface.

This novel technology has high potential for use in biological assays, immunoassays, and for studying biophysical properties of biological macromolecules.