Spontaneous Emission and Energy Transfer Rates Near Metal Nanostructures

V. Karanikolas

School of Physics and CRANN, Trinity College Dublin, Dublin 2

E-mail:karanikv@tcd.ie

Light-matter interactions are crucial for a variety of applications, such as light harvesting, light guiding, imaging and quantum optics. Atoms, dyes and quantum-dots (QDs) can be approximated by two-level systems. The spontaneous emission (SE) and the energy transfer (ET) rates of quantum emitters (QEs) are modified in the presence of material bodies in their environment. Particularly when metal structures are considered, the SE and ET rates can be enhanced by several orders of magnitude, compared with their free space values, due to the excitation of surface plasmon (SP) modes. SPs are electromagnetic modes that propagate along the interface between a dielectric and a conductor. At the dielectric-conductor interface collective oscillations of the metallic electrons and the electromagnetic field can exist and propagate along the interface.

In this talk we investigate the SE rate, γ, and ET rate, Γ, for planar[1] and cylindrical[2] structures consisting of metallic and dielectric elements. These rates are calculated using the semi-analytical Green's tensor method [3]. We consider Ag and Au as metallic elements because the SP wavelength of these metals lies in the visible part of the spectrum. Since SE and ET are competitive processes an ET efficiency[4] is introduced in order to find the optimal geometrical characteristics for a specific process.

We also consider arrays of metallic elements, in particular Ag nanoboxes of sizes 100nm*100nm*40nm on top of Ga/InGaN quantum well, for possible applications for light emitting devices. Using FDTD techniques, we are able to find the Green's tensor of this arrangement and, therefore, to estimate the ET efficiency.

References

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