Mesoscopic Materials Research Laboratory Seminar

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Room **204,** Science and Technology Research Building 3

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Erbium photoluminescence dynamics in the presence of size controlled silicon nano-crystals

Rapid thermal annealing is used to control the ensemble size distribution of silicon nanocrystals in thin silica (SiO_2) films co-implanted with erbium (Er) ions. The nano-crystal size distributions have been characterized using dark field mode X-TEM and are well described by a lognormal probability distribution function which provides characteristic values for the mean size, $\bar{L}$ and the standard deviation, σ. Under non-resonant (473nm) pumping, the photoluminescence (PL) transients associated with the Er^{3+} first excited ($^4I_{13/2}$) to ground state ($^4I_{15/2}$) transition (1534nm) reveal a multi-exponential character indicative of the local environment of the emitting centres. A detailed analysis of the decay transients reveals two distinct classes of luminescent erbium; one of these populations, at a distance on the order of a bond length (~0.3nm) from the nano-crystal interface, exhibits a relatively short radiative lifetime (between 3 and 5ms) dependent on the size of the neighbouring nano-crystal. Calculations reveal that this may be attributed to a *Purcell*-like enhancement of the radiative rate induced by local changes in the refractive index for the Er close to a spherical dielectric interface. The second population, which exhibits a much longer lifetime (between 10 and 15ms), is characteristic of that of Er in a stoichiometric SiO_2 host, i.e. far from any silicon nano-crystals. The presence of a fast component (between 500 and 800μs) in all of the transients is attributed to non-radiative ion-ion interactions as a result of the formation of Er/Er-O clusters.