Interaction mechanism for energy transfer from Ce to Tb ions in silica and LaF_3

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Energy transfer phenomena can play an important role in the development of luminescence materials. One way to enhance the luminescence efficiency is through energy transfer between a donor and an acceptor. Among lanthanide ions, Ce^{3+} is an ideal donor candidate due to its allowed f-d absorption and its broad emission band which can overlap the acceptor absorption band. The bright green emission of Tb^{3+} makes this ion a popular acceptor of the lanthanide group. Forster developed a theory for the rate of non-radiative energy transfer by electric dipole-dipole interaction. This was later extended by Dexter to involve the higher multipole interactions and exchange interaction. Inokuti and Hirayama developed numerical methods on energy transfer that determine the mechanism responsible. In the study, the mechanism responsible for the energy transfer between Ce and Tb was investigated by fitting the luminescence intensity and the lifetime of the donor as a function of acceptor concentration to the Inokuti and Hirayama theoretical models.

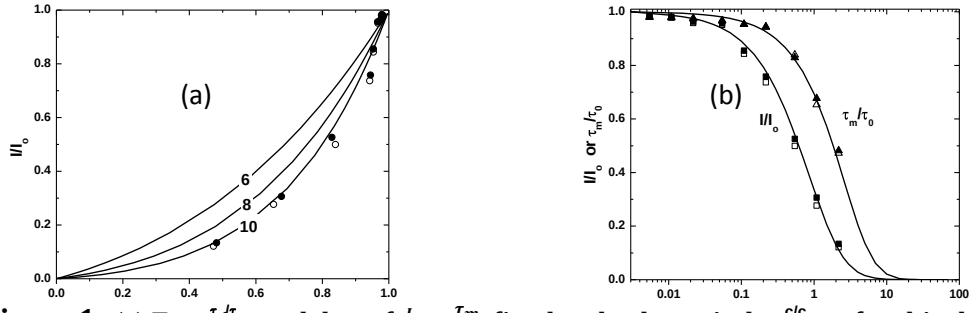

Figure 1: (a) Experimental data of $\frac{I}{I_0}$ vs $\frac{\tau_m}{\tau_0}$ fitted to the theoretical curves of multipole interaction. (b) Experimental data of $\frac{I}{I_0}$ and $\frac{\tau_m}{\tau_0}$ vs $\frac{c}{c_0}$ fitted to the theoretical curves of quadrupole-quadrupole interaction.

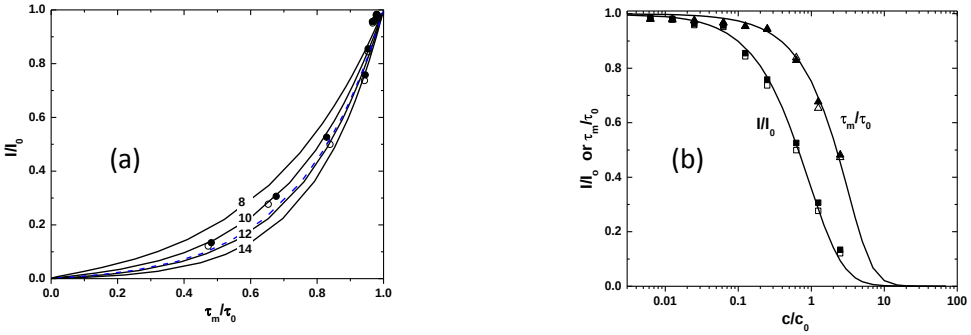

Figure 2: (a) Experimental data of $\frac{I}{I_0}$ vs $\frac{\tau_m}{\tau_0}$ fitted to the theoretical curves of exchange interaction. The blue dashed line gives the best fit (γ = 11.6). (b) Experimental data of $\frac{I}{I_0}$ and $\frac{\tau_m}{\tau_0}$ vs $\frac{c}{c_0}$ fitted to the theoretical curves of exchange interaction.