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

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Abstract content
   (Max 300 words)

Energy transfer phenomena can play an important role in the development of luminescence materials. For example, the green luminescence from Tb³⁺ doped silica can only be excited efficiently using very short wavelength UV light near 227 nm. However, the excitation wavelength can be shifted to a more accessible value of 325 nm by co-doping with Ce³⁺ ions which absorb at this wavelength and then transfer the energy to the Tb³⁺ ions. Inokuti and Hirayama developed models for radiationless energy transfer that occurs via the exchange interaction or various types of multipole interactions. In this work numerical simulations based on these theoretical models are compared to experimental results obtained for the energy transfer from Ce to Tb in sol-gel silica. The experimental results were obtained by exciting samples with a fixed concentration of Ce (the donor) and varying the concentration of Tb (the acceptor). Energy transfer from the donor to the acceptor results in a decrease in the donor (Ce) luminescence intensity and lifetime. It was found that the decrease in the donor intensity corresponded well with the energy transfer models based on the exchange and dipole-dipole interaction. The critical transfer distance obtained from the fitting using both models is around 20 angstrom suggesting that the dipole-dipole interaction is more appropriate than the exchange interaction which requires a distance shorter than 10 angstrom to occur. Although the donor decay lifetime data has the same trend as the corresponding theoretical curve, it does not decrease as much as expected. The decay curves from pure Ce-doped silica are not simple exponential decays as expected. This indicates that Ce ions may occur in different environments in the amorphous silica hosts, and these have different lifetimes, complicating the analysis of the lifetime data.

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PhD

Main supervisor (name and email)
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