Sol-gel derived nano-glass-ceramics comprising RE-doped KYF_4 nanocrystals

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Glass-ceramics containing rare-earth (RE) doped nanocrystals are considered to play an important role in the development of new luminescent materials in areas such as photo-electronic devices, white light up-conversion phosphors, solid state lasers, solar cells and biological labels [1]. These materials can be synthesized by the room temperature sol-gel method with the advantages of its low cost, easiness, controlled concentration and size, excellent purity and dispersion [2]. KYF_4 is very attractive host for RE ions for providing high intensity VUV and visible up-conversion emissions, under IR excitation, due to its very low phonon energy environment which enhances luminescence. Among RE ions, Eu^{3+} is highly sensitive to the local structure and it is used as a probe of final environment for the ions, key factor for resultant quantum efficiency of the luminescent materials. Tm^{3+} is well known for its IR to UV and blue up-conversion emissions. By co-doping with Yb^{3+}, these emissions can be intensified remarkably due to larger absorption cross-section of Yb^{3+} and the high efficient energy transfer to Tm^{3+} ions. We have successfully developed, for the first time to our knowledge, sol-gel derived nano-glass-ceramics containing RE-doped KYF_4 nanocrystals, after adequate heat treatment of precursor glasses. Here, we report a complete site selective resolved spectroscopic study by means of Eu^{3+}-doped samples as a function of heat-treatment temperature. By other side, we also report high efficient UV up-conversion emissions in Yb^{3+}-Tm^{3+} co-doped samples as a function of Yb^{3+} concentration and thermal treatment temperature. These unusually high energetic UV emissions, protected from non-radiate decays provided by the low phonon energy host of KYF_4 nanocrystals, represent a significant progress in the search of new stable species for applications in optical materials for solid state UV sources.

References

[1] Y. Ying and A.P. Alivisatos, Nature **437** (2005) 664
[2] J. Méndez-Ramos et al. J. Nanosci. Nanotechnol. **10** (2010) 1273