Nanocomposites and nanomaterials

Photoluminescence emission spectra of Eu-doped synthetic opals as photonic crystals

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In this work, we report experimental studies on spectral redistribution of photoluminescence intensity of Eu^{3+} infiltrated in synthetic opals as photonic crystals. Opal photonic crystals filled with rare earth ions, as luminescence concentrator and back reflector, are potentially attractive for improving solar cell efficiency [1, 2].

Infiltration was carried out by dipping the opals into a europium salt water solution such as Europium (III) acetate hydrate ($C_6H_9EuO_6$ x H_2O) (99.9% trace metals basis). The samples with different position of the stop-band within the range 585 – 620 nm were used. The excitation source used was LD operating at wavelength of 400 nm. The average power of the excitation light sources was 100 mW. The laser light irradiated the sample perpendicular to (111) growth surface. The emission spectra from the infiltrated opals were measured from the back side of the opal plate utilizing a Specol-11 spectrometer with spectral resolution of 1 nm.

In measured spectra typical luminescence bands of Eu^{3+} at wavelength 588 nm ($^5D_0 \rightarrow {}^7F_1$), 613 nm ($^5D_0 \rightarrow {}^7F_2$) and 690 nm ($^5D_0 \rightarrow {}^7F_4$) were observed. There was an overall increase in the intensity of the luminescence spectrum as compared with the spectrum of a europium salt, which may be due to multiple scattering processes of light in the bulk of the nanocomposite, which increases the interaction time of the exciting radiation with substance in the pores of opal. A strong narrow luminescence line in the vicinity of 613 nm due to the $^5D_0 \rightarrow {}^7F_2$ electric dipole transition demonstrate inhibition of the spontaneous emission in opal with stop-band center at λ_c = 620nm.

1. *Li M., Zhang P., Li J., Zhou J., Sinitskii A., Abramova V., Klimonsky S.O. and Tretyakov Y.D.* Directional emission from rare earth ions in inverse photonic crystals // Appl. Phys. B-2007.-**89**.-P.251-255.
2. *Zeng L., Bermel P., Yi Y., Alamariu B. A., Broderick K. A., Liu J., Hong C., Duan X., Joannopoulos J., and Kimerling L. C.* Demonstration of enhanced absorption in thin film Si solar cells with textured photonic crystal back reflector // Applied Physics Letters -2008.-**93**.-221105 (3pp).