Luminescence Dependence of Pr^{3+} Activated SiO_2 Nanophosphor on Pr^{3+} Concentration, Temperature, and ZnO Incorporation

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ABSTRACT

Green-emitting ZnO nanoparticles were successfully embedded in Pr^{3+}-doped SiO_2 by a sol-gel method resulting in a red-emitting ZnO SiO_2:Pr^{3+} nanocomposite phosphor. The particle morphology and luminescent properties of SiO_2:Pr^{3+} phosphor powders, with or without ZnO nanoparticles, were, respectively, investigated by electron microscopy and luminescence spectroscopy. Luminescence of SiO_2:Pr^{3+} was studied as a function of different Pr^{3+} concentrations and temperature. Both Pr^{3+} concentration and temperature were found to influence the $^1D_2$ emission from Pr^{3+} strongly. Defects emission from ZnO nanoparticles was measured at 517 nm compared with the normal peak at 470 nm from micrometer-sized ZnO powders. Only red emission at 614 nm from Pr^{3+} ions in SiO_2:Pr^{3+} and ZnO SiO_2:Pr^{3+} was observed. The green emission from ZnO in ZnO SiO_2:Pr^{3+} was quenched, and the red emission from Pr^{3+} was doubly enhanced compared with SiO_2:Pr^{3+}. The enhancement of the PL intensity from SiO_2:Pr^{3+} with ZnO incorporation denotes the presence of energy transfer from ZnO to Pr^{3+} ions.