Cathodoluminescence properties of SiO$_2$:Pr$^{3+}$ and ZnO-SiO$_2$:Pr$^{3+}$ phosphor nanopowders

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**ABSTRACT:**

The successful incorporation of ZnO nanoparticles in Pr$^{3+}$-doped SiO$_2$ using a sol–gel process is reported. SiO$_2$:Pr$^{3+}$ gels, with or without ZnO nanoparticles, were dried at room temperature and annealed at 600 °C. On the basis of the X-ray Diffraction (XRD) results, the SiO$_2$ was amorphous regardless of the incorporation of Pr$^{3+}$ and nanocrystalline ZnO or annealing at 600 °C. The particles were mostly spherical and agglomerated as confirmed by Field Emission Scanning Electron Microscopy. Thermogravimetric analysis of dried gels performed in an N$_2$ atmosphere indicated that stable phases were formed at ≥900 °C. Absorption bands ascribed to $^3H_4$$^3P$($J=0,1,2$), $^1I_6$ and $^1D_2$ in the UV–VIS region were observed from SiO$_2$:Pr$^{3+}$ colloids. The red cathodoluminescent (CL) emission corresponding to the $^3P_0$$^3H_6$ transition of Pr$^{3+}$ was observed at 614 nm from dried and annealed SiO$_2$:Pr$^{3+}$ powder samples. This emission was increased considerably when ZnO nanoparticles were incorporated. The CL intensity was measured at an accelerating voltage of 1-5 keV and a fixed beam current of 8.5 μA. The effects of accelerating voltage on the CL intensity and the CL degradation of SiO$_2$:Pr$^{3+}$ and ZnO-SiO$_2$:Pr$^{3+}$ were also investigated using Auger electron spectroscopy coupled with an Ocean Optics S2000 spectrometer.