Sol-gel preparation and luminescent properties of CeO_2:Ln (Ln = Eu^{3+} and Sm^{3+}) thin films

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Abstract
Recent progress in ultraviolet light emitting diodes (UVLEDs) has opened possibility of designing new opto-electronic devices. UV-pumped phosphors are one of the key materials for such devices. Especially, luminescence from rare earth shows sharp spectrum, which is effective phosphors in display device, solid-state laser and etc. In this work, new transparent CeO_2:Ln (Ln = Eu^{3+} or Sm^{3+}) thin-film phosphors have been fabricated by a sol-gel method. Homogeneous precursor solutions, with Ln concentrations varied between 0.05 and 100 at.%, were obtained by dissolving a mixture of pertinent metal acetates and trifluoroacetic acid in ethanol. The solutions were deposited on silica glass substrates by spin-coating and then heated at 700°C in air. Fluorite-type crystalline phases were formed in all the films, although their chemical compositions seemed to change from CeO_2:Ln to LnOF depending on the Ln concentration. CeO_2:Ln films with the Ln concentrations of 1 at.% showed the strongest photoluminescence (PL) upon ultraviolet (UV) light excitation. At higher Ln concentrations, the PL intensity decreased because of the nonradiative energy transfer between Ln ions as luminescent centers. For Eu^{3+} ions doped in the CeO_2 lattice with inversion symmetry, an orangish red emission due to a magnetic-dipole $^5D_0 \rightarrow {}^7F_1$ transition (591 nm) was dominant without other strong $^5D_0$-related emissions when excited at a wavelength of 340 nm. In contrast, much stronger orange emissions (573 nm) due to $^4G_{5/2} \rightarrow {}^6H_{5/2}$ were observed for Sm^{3+} ions. Apparently, the Eu^{3+} and the Sm^{3+} ions had different efficiencies of the excitation through the energy transfer from the "Ce^{4+}–O^{2-}" charge transfer state induced by the UV irradiation.