Broadband orange phosphor by energy transfer between Ce^{3+} and Mn^{2+} in $Ca_3Al_2Ge_3O_{12}$ garnet host.

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Streszczenie

Ca3Al2Ge3O12 phosphors, singly doped with Ce^{3+} and co-doped with Mn^{2+}, were synthesized by the solid-state reaction in ammonia atmosphere at 1200 °C using Li2CO3 as a flux. The band gap energy of the host was determined to be 3.7 eV. In these phosphors, Ce^{3+} ions exclusively occupy the Ca^{2+} site, while Mn^{2+} ions occupy both the Ca^{2+} and Al^{3+} sites. Under 420 nm excitation, the Ce^{3+}:Ca3Al2Ge3O12 phosphor emits bluish-green light from Ce^{3+} (470 nm) with a Stokes shift established at 2280 cm^{-1}. The Ce^{3+}/Mn^{2+}:Ca3Al2Ge3O12 phosphor excited at 420 nm emits orange light (580 nm) from Mn^{2+} in the Ca^{2+} site due to the $Ce^{3+} \rightarrow Mn^{2+}$ energy transfer almost exclusively to this site. Ce^{3+} emission in the co-doped phosphor is very weak, even for relatively small concentrations (1%) of Mn^{2+}. For Mn^{2+} concentration of 5% it disappears almost completely. Luminescence quantum yields of these phosphors amount to 24% and 20% in the case of Ce^{3+}:Ca3Al2Ge3O12 and Ce^{3+}/Mn^{2+}:Ca3Al2Ge3O12, respectively. The critical distance for $Ce^{3+} \rightarrow Mn^{2+}$ energy transfer was calculated to be 6.2 Å and the efficiency of the energy transfer was estimated as 88%. These parameters suggest a non-uniform distribution of doped ions and the formation of Ce-Mn clusters.

Słowa kluczowe

Ca3Al2Ge3O12 garnet phosphor, melamine as reducing agent, photoluminescence, Ce/Mn energy transfer, Phosphor for w-LED, Cluster luminescence

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