Luminescence and Thermal-Quenching Properties of Red-Emitting Ca2Al2SiO7:Sm3+ Phosphors

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Abstract

Ca2Al2SiO7:x.Sm3+ (x = 0.5, 1.0, 1.5, 2.0, 2.5, and 3.5 mol.%) (CAS:x.Sm3+) phosphors were synthesized by a solid-state reaction technique. The structure, photoluminescence properties and thermal stability of phosphors were investigated in detail. Results of X-ray diffraction show that CAS:x.Sm3+ materials have a single-phased tetragonal structure, and an expansion of the unit cell relates to the increasing of Sm3+ concentration. Photoluminescence study displayed that the CAS:x.Sm3+ phosphors reach the highest emission intensity at 1.5 mol.% Sm3+ and achieved the luminescence quenching phenomenon a higher concentration. The dominant interaction mechanism of the concentration quenching process is determined due to the dipole–dipole interaction, and the critical transfer distance (Rc) is 26.7 Å. The temperature dependence of photoluminescence spectra indicates that the Ca2Al2SiO7:Sm3+ (1.5 mol.%) phosphor possess good thermal stability, and that the activation energy is around 0.12 eV (968 cm−1). Several characteristic vibrations in the 200–1000-cm−1 region were observed by Raman spectra, and the color chromaticity coordinates of the samples were also calculated and discussed.