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Increasing the red emission of Mn4+ in magnesium aluminate by alloying with TiO2

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Mn4+ activated oxides are highly stable, low cost and environmental safety materials that can be used as red phosphors in luminescence thermometry and phosphor-converted white light-emitting diodes. In MgAl2O4 spinel, the Mn4+ photoluminescence (PL) band with a peak at 651 nm is within human eye's sensitivity spectral range, but its luminous efficacy needs to be increased. In this work, the effect of alloying with TiO2 on optical and structural properties of Mn4+ activated MgAl2O4 ceramics produced by solid state reaction was studied. In the alloyed phosphors, the number of Al and Ti atoms was the same.
X-ray diffraction study of MgAl2O4:Mn ceramics revealed that concentration of spinel phase increased with annealing temperature up to 96% at 1400℃. In TiO2-alloyed ceramics, two crystalline phases of solid solutions were identified: spinel and qandilite, the concentration of former decreased and of latter increased with annealing temperature. In the PL spectra recorded under synchrotron radiation excitation, the PL bands caused by 2E⟶4A2 transition of Mn4+ in the Al2O3, MgAl2O4 and qandilite solid solution were identified. The CIE coordinates of MgAl2O4 and TiO2-alloyed ceramics were (0,6932, 0,2902) and (0,6953, 0,2894), respectively. The MgAl2O4:Mn ceramics also showed intense green PL caused by 4T1⟶6A1 transitions of Mn2+. The presence of Mn2+ in MgAl2O4 host was confirmed by electron paramagnetic resonance study. The TiO2-alloyed ceramics demonstrated several times larger intensity of Mn4+ PL and no Mn2+ PL. It is concluded that alloying of MgAl2O4:Mn4+ with TiO2 is a promising approach for increasing the luminous efficacy of red phosphor.

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