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Enhanced luminescence from Tb for the mixed spinel Mg_xZn_{1-x}Al₂O₄

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Abstract content
   (Max 300 words)

Spinels, which have the general formula AB2O4, often occur naturally as minerals but are also synthesized and studied for their interesting electrical, magnetic and optical properties. MgAl2O4 finds diverse applications due to its mechanical strength, chemical inertness, relatively low density, high melting point, high thermal shock resistance, low thermal expansion coefficient, resistance to neutron irradiation and low dielectric loss. It has also been used as a phosphor host activated by a variety of transition metal and lanthanide ions. ZnAl2O4 is widely used as a catalyst and has recently attracted much attention as a phosphor host. Both have been studied separately as possible hosts for Tb, but in this work they were compared directly. Results were also obtained for Tb-doped mixed spinels MgxZn1-xAl2O4. Although the lattice constant changes little with composition, the bandgap of MgAl2O4 (7.8 eV) is double that of ZnAl2O4 (3.9 eV). Nanocrystalline powder samples with a particle size of about 25 nm were prepared using the combustion method. For MgAl2O4:Tb(0.5 mol%) both green emissions due to 5D4-7FJ transitions (with the most intense 5D4-7F5 transition at 544 nm) and blue emissions due to 5D3-7FJ transitions were observed. Less intense green emissions were observed for ZnAl2O4:Tb(0.5 mol%) and no blue emission occurred. Both samples had similar excitation spectra (for 544 nm emission), with a peak near 230 nm which is attributed to the Tb 4f-5d transition. This was unexpected due to the large difference in their bandgaps. This excitation wavelength corresponds to an energy of 5.4 eV which is higher than the bandgap of ZnAl2O4. Therefore a fraction of the incident light will be absorbed by this host and not be available to excite the Tb ions, which corresponds to the observation of poorer luminescence from the ZnAl2O4:Tb. The absence of blue emission peaks is usually attributed concentration quenching, but since the same Tb concentration was used for the MgAl2O4:Tb where blue emissions did occur, it is rather suggested that because of the smaller bandgap of ZnAl2O4, the 5D3 level lies close to or inside the conduction band and this prevents transitions from this level. The maximum green emission was measured for the mixed spinel Mg0.75Zn0.25Al2O4:Tb(0.5 mol%), although the blue emissions from this sample were less than for the MgAl2O4 host.

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