

Luminescent and electrical properties of Mg²⁺ or Zr⁴⁺ co-doped LiGa₅O₈:Mn²⁺,Cr³⁺ phosphors

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The study of spinel oxides is attracting considerable attention due to their unique chemical and physical properties and potential applications in phosphors, lasers, and optoelectronic components, etc. Gallate spinel doped with manganese and chromium ions exhibits a diverse set of luminescent properties, regulated by site coordination, valence state, and lattice defects. LiGa₅O₈ is a promising host material due to its diverse coordination environments and large number of defects. Due to their similar ionic radii, Li⁺ and Ga³⁺ can readily substitute for each other in octahedral sites, leading to the formation of intrinsic defects, such as oxygen vacancies and Li/Ga antidefects.

In this work, LiGa₅O₈:Mn²⁺ phosphors co-doped with Cr³⁺ and Mg²⁺/Zr⁴⁺ were synthesized by a high-temperature solid-state reaction method. The structural, optical, and electrical properties of the obtained materials were investigated using X-ray diffraction, photoluminescence and photoluminescence excitation spectroscopy, afterglow measurements, and impedance spectroscopy.

The X-ray diffraction results confirmed the formation of the LiGa₅O₈ spinel phase. Photoluminescence studies revealed the coexistence of green Mn²⁺ emission, assigned to the ⁴T₁→⁶A₁ transitions, and red Cr³⁺ emission associated with the ²E→⁴A₂ transitions. The persistent luminescence behavior was found to depend on excitation conditions and temperature, indicating the involvement of both shallow and deep trapping states in charge storage and release. Additional co-doping with Mg²⁺ or Zr⁴⁺ mainly affected the redistribution of intensities among the elementary emission bands. Impedance spectroscopy further showed that the electrical response of LiGa₅O₈-based phosphors can be tuned by controlled co-doping with Mn²⁺/Cr³⁺ and Mg²⁺/Zr⁴⁺ ions, reflecting changes in carrier concentration, defect-related conductivity, and charge-transport mechanisms.

These results demonstrate that co-doping with transition-metal and divalent or tetravalent cations enables control over both the luminescent and electrical properties of LiGa₅O₈, making this material a promising candidate for optoelectronic applications.

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