Faculty of Science and Technology
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Development of Oxide-Based Phosphors Excitable by Visible and Ultraviolet Light

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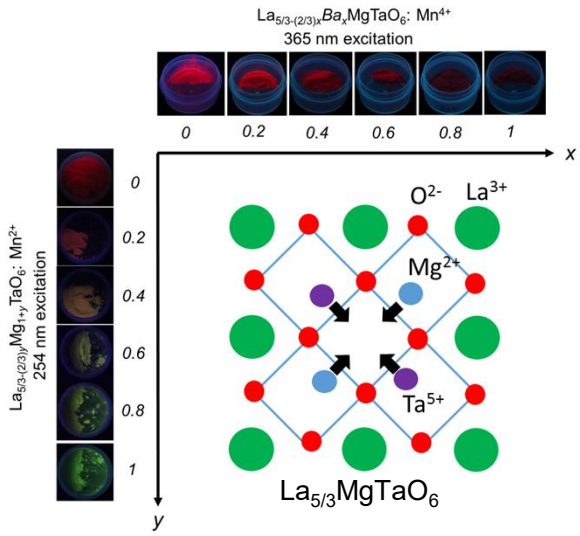

Fig. 1 Photographs of Mn-activated perovskite-type oxide-based phosphors under UV excitation.

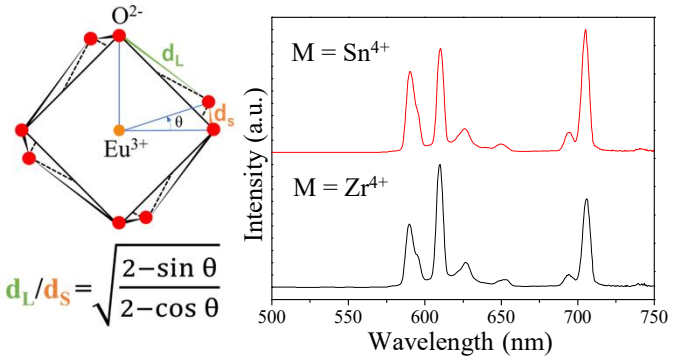

Fig. 2 Emission spectra of garnet-type oxide-based phosphors.

Research Overview

White LEDs are generally composed of blue LEDs and yellow phosphors; however, their low color rendering performance due to insufficient red emission remains a challenge. Therefore, the development of red-emitting phosphors that can be excited by ultraviolet or blue light has been actively pursued. However, many red phosphors require high-pressure and reducing atmospheres during synthesis. In this study, we focus on the development of oxide-based red phosphors that can be synthesized under ambient atmospheric conditions.

Development of Perovskite- and Garnet-Type Red Phosphors

A perovskite-type red phosphor based on $La_5/_3MgTaO_6$ with Mn as the luminescent center was developed. The crystal structure and luminescence properties can be tuned by controlling the amount of A-site deficiencies in the host lattice or by changing the elements used to compensate for these vacancies. These structural modifications enable the modulation of both emission intensity and wavelength.

The emission wavelength of garnet-type $Ca_2EuM_2Ga_3O_{12}$ (M = Zr^{4+}, Sn^{4+}) red phosphors is strongly influenced by the coordination environment of Eu^{3+}. The sharp emission lines of Eu^{3+} around 610 and 710 nm are related to its local symmetry. When Eu^{3+} occupies an antiprismatic site with D_{4d} symmetry, the intensity of the 710 nm emission line is enhanced. By replacing the M cation from Zr^{4+} to Sn^{4+} in $Ca_2EuM_2Ga_3O_{12}$, the local symmetry around Eu^{3+} approaches D_{4d} symmetry, resulting in enhanced 710 nm emission. This relationship was clarified through a combination of crystal structure analysis, geometric calculations of the Eu^{3+}-centered polyhedra, and photoluminescence measurements.

In future studies, I aim to develop novel phosphors exhibiting emission not only in the visible region but also in the near-infrared region. Furthermore, I will explore new host materials with novel crystal structures and investigate their potential applications as phosphors.

Keywords : Phosphor, Crystal structure analysis
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