

Beyond Luminescence to Understand Phosphors. The Case of Ba₂LaNbO₆:Mn and its Derivatives

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In recent years, the interest in efficient red light-emitting phosphors, particularly those activated with Eu²⁺ or Mn⁴⁺ ions, has grown significantly. The focus is on developing narrow and ultra-narrow emitters to advance high-color gamut LED phosphors for various applications. Understanding the interaction between activators and ligands, especially for environmentally sensitive ions like Eu²⁺ or Mn⁴⁺, is essential for designing such new phosphors. This presentation shows spectroscopic studies of Mn⁴⁺-activated double perovskites Ba₂LaNbO₆, Ba₂La[Nb_{0.8}Zr_{0.1}W_{0.1}]O₆, and Ba₂La[Zr_{0.5}W_{0.5}]O₆. The main focus was to investigate the impact of chemically-induced structural distortion when Nb was gradually substituted with (Zr,W) pairs, anticipated to increase the Zero-Phonon Line (ZPL) of Mn⁴⁺ transition probability by disturbing the dopant's octahedral local symmetry [1]. These findings were compared with the EPR spectra. For Ba₂LaNbO₆:Mn and Ba₂La(Nb_{0.8}Zr_{0.1}W_{0.1})O₆:Mn, only intense lines characteristic of Mn²⁺ were observed, indicating similar Mn²⁺ concentrations in both samples. In contrast, narrow luminescence features from Mn⁴⁺ could be seen in these phosphors. In Ba₂La[Zr_{0.5}W_{0.5}]O₆, both Mn²⁺ and Mn⁴⁺ were found in the EPR, and the Mn⁴⁺ emission bands appeared broader, in agreement with the higher concentration of Mn⁴⁺ as verified by EPR.

The absence of Mn²⁺ luminescence in all three materials will be discussed. We will demonstrate a correlation between the introduced disorder of the cationic subsystem and the experimental and calculated energy of the Mn⁴⁺ emitting ²E_g level (R-line) as well as its intensity. The conducted EPR studies indicate the need for further research to comprehend the interplay between different Mn ions in the materials under investigation.

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