

Investigation of the local environment of luminescent chromium ions in the near-infrared (NIR-I/II) range by electron paramagnetic resonance (EPR) technique

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The most common and economically viable luminescent ion in the near infrared (NIR) range are chromium ions. The position and shape of the luminescence in the NIR range depend on the local environment of the chromium ions. Single Cr³⁺ ions in an octahedral environment radiate in the 650 - 800 nm range, Cr³⁺-Cr³⁺ ion pairs in the 750 - 1100 nm range, and single Cr⁴⁺ ions in a tetrahedral environment in the 1100 - 1600 nm range. Luminescence in the latter range can also be achieved by inter-valence charge transfer between Cr³⁺-Cr²⁺/Cr⁴⁺ pair interactions in an octahedral environment. The exact position of the luminescence maximum and the shape of the luminescence spectrum depend on the crystal field and the distortion of the nearest environment of the luminescent ions. X-ray diffraction (XRD) studies make it possible to determine the structure of the compound matrix, without information on dopants, especially when we have small amounts of doped luminescent ions. Locations of chromium ions are determined based on the ionic radius and valence state of the substituted ions. However, this is an assumption and not scientific information. Scientific information should be confirmed experimentally. The technique that is able to determine the closest environment of luminescence ions (which are usually also paramagnetic ones) is the EPR technique. Even small amounts of doping of luminescent ions make it possible to determine the nearest environment of luminescent ions. In addition, it identifies the symmetry and distortion of this environment. This is the only technique that allows to study the local environment of even a small amount of paramagnetic luminescent ions.

In this presentation, I will focus on the analysis of the near environment of chromium ions in Y₃Al₅O₁₂ (YAG) phosphors doped with Cr³⁺ ions and co-doped with Ca²⁺ and Mg²⁺ ions, and the analysis of the local environment of chromium ions for LiGa₅O₈ (LGO) phosphors doped with Cr³⁺ ions. All compounds were prepared by the team of Prof. Ru-Shi Liu (NTU) and luminescence studies were performed by the team of Prof. Sebastian Mahlik (UG). EPR studies were performed at the Nanomaterials Physicochemistry Department at the West Pomeranian University of Technology in Szczecin.

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