

Crystal Structure as a Knob: Modulating Blue-to-UV Upconversion Performance in Pr³⁺-Doped REBO₃ (RE = Y, La, Lu) Phosphors

Patrycja Zdeb-Stańczykowska^{1,#}, Nadiia Rebrova¹, Markus Suta², Leonardo Saraiva³, and Przemysław J. Dereń^{1,#}

¹ Institute of Low Temperature and Structure Research (ILTSR), Polish Academy of Science, ul. Okólna 2, 50-422 Wrocław, Poland.

² Institute of Inorganic Chemistry, Heinrich-Heine Universität Düsseldorf (HHU), Düsseldorf, 40225, Germany.

³ Department of Chemistry and Biochemistry, School of Science and Technology, São Paulo State University (UNESP), Presidente Prudente, São Paulo, 19060-900, Brazil.

The development of Pr³⁺-based phosphors that efficiently convert blue light into ultraviolet (UV) radiation [1] is a critical challenge for the realization of innovative UV sources, such as phosphor-converted UV LEDs (pc-UV-LEDs). In this work, we present a systematic investigation of Pr³⁺-doped rare-earth orthoborates REBO₃ (where RE = Y, La, Lu) as blue-to-UV upconversion phosphors. We exploit the structural diversity of this family— which contain aragonite-type (LaBO₃), pseudo-wollastonite-type (π -LuBO₃ and YBO₃), and calcite-type (β -LuBO₃) crystal structures [2]—to tune the upconversion performance. Utilizing UV photoluminescence spectroscopy and temperature-dependent time-resolved measurements, we systematically evaluate how the crystallographic environment of the Pr³⁺ ion influences the energy positioning of the 4f¹5d¹ levels [3], the Stokes shift of the UV luminescence, and the thermal quenching temperature (T_{50}). These spectroscopic findings are correlated with the recorded blue-to-UV upconversion spectra to identify the optimal host structure, thereby establishing rational design principles for high-efficiency upconverters. Finally, the practical potential of the selected materials is demonstrated by observing blue-to-UV upconversion under excitation from a commercial 450 nm LED, supporting their applicability in pc-UV-LED devices.

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corresponding authors: p.zdeb@intibs.pl and p.deren@intibs.pl