

PROTOTYPE OF A WHITE LED WITH GLASSY NaF-AL₂O₃-P₂O₅: EU PHOSPHOR

Mateusz Słotwiński¹, Agata Jaročka¹, Tomasz Pietrzak¹

¹Warsaw University of Technology, Faculty of Physics, Solid State Ionics Division, Warsaw, Poland
mateusz.slotwinski.stud@pw.edu.pl

One of the key research directions in modern optoelectronics and materials physics is the development of white LEDs with emission spectra closely resembling natural light, while maintaining low production costs. This work presents both the prototyping stage and the characterization of innovative luminescent materials based on a NaF-Al₂O₃-P₂O₅ glass matrix doped with europium.

The key element of the project is the utilization of the partial reduction of europium ions (Eu³⁺ → Eu²⁺) during synthesis via the melt-quenching method in a reducing atmosphere. Through precise control of temperature and melting time, it is possible to manage the concentration ratio of active centers, allowing for the seamless adjustment of the emission color—ranging from amaranth, through warm white, to cool white. In this system, the glass matrix plays a dual role: it serves as a stable substrate for the luminescent ions and acts as a durable mechanical shield.

As part of the research, a complete LED lamp prototype was designed and fabricated, consisting of:

- The glass phosphor,
- A steel housing and a dedicated stand with an adjustable beam angle,
- An aluminum reflector to optimize light extraction, utilizing a UV LED as the excitation source.

Furthermore, material characterization was conducted, including confirmation of the amorphous structure (XRD), determination of thermal parameters (DTA), and optical properties (absorption and photoluminescence spectroscopy).

The research results confirm that the use of europium-doped fluorophosphate glasses allows for a continuous and smooth emission spectrum, highly similar to sunlight.

Keywords: LED, optoelectronics, glass matrix, phosphor, photoluminescence, rare-earth metals, materials engineering, solid-state physics, materials physics, technical design

[1] A. Jaročka, B. Fetiński, P. Dębowski, T. K. Pietrzak, K. Jurak, and M. Wasiucione, "Facile and cost-effective technique to control europium oxidation states in glassy fluorophosphate matrices with tunable photoluminescence," *Scientific Reports*, vol. 12, no. 1, p. 18774, Nov. 2022, doi: 10.1038/s41598-022-21981-z.
[2] T. K. Pietrzak et al., "Photoluminescence of partially reduced Eu²⁺/Eu³⁺ active centers in a NaF-Al₂O₃-P₂O₅ glassy matrix with tunable smooth spectra," *Journal of Luminescence*, vol. 208, pp. 322–326, Dec. 2018, doi: 10.1016/j.jlumin.2018.12.060.