

# The effect of lithium excess on the persistent luminescence and thermoluminescence performance of undoped and Cr<sup>3+</sup>-doped Li<sub>1+x</sub>Ga<sub>5</sub>O<sub>8</sub> spinel

A. Karabut<sup>1,#</sup>, H. Zhydachevska<sup>1</sup>, V. Hreb<sup>2</sup>, L. Vasylechko<sup>2</sup>, Ya. Zhydachevskyy<sup>1</sup>

<sup>1</sup> Institute of Physics, Polish Academy of Sciences, Warsaw, Poland

<sup>2</sup> Lviv Polytechnic National University, Lviv, Ukraine

Lithium-gallium spinel (LiGa<sub>5</sub>O<sub>8</sub>) activated with rare-earth (RE) or transition metal (TM) ions is a known crystalline phosphor having long-lasting persistent luminescence (PersL), thermally stimulated luminescence (TSL) and mechanoluminescence (ML) properties. In particular, when activated with Cr<sup>3+</sup>, it exhibits persistent luminescence in the deep red spectral region at about 700 nm. When undoped, the LiGa<sub>5</sub>O<sub>8</sub> spinel demonstrates an efficient broad-band intrinsic photoluminescence (PL) in the violet-blue spectral region at about 400 nm, however, having very poor PersL at room temperature. The radiation storage properties allowing the PersL, TSL and ML of the material are caused by intrinsic point defects, such as cation antisites, cation and oxygen vacancies that are highly probable in this spinel compound (see e.g. [1]). Recently, we have shown the possibility of tuning the optical band gap, crystal structure and persistent luminescence performance of Cr<sup>3+</sup>-doped LiGa<sub>5</sub>O<sub>8</sub> spinel by partially replacing Ga with Al and/or In [2]. The present work aims to go further and to get a better insight into the nature of the intrinsic point defects responsible for the charge trapping and their targeted modification with the purpose of improving the PersL and TSL properties of the material. In particular, the effect of lithium excess on the PersL and TSL properties of the Li<sub>1+x</sub>Ga<sub>5</sub>O<sub>8</sub>-based phosphors has been studied in detail. For this purpose, a few series of LiGa<sub>5</sub>O<sub>8</sub>-based compounds with different Li/Ga ratios, nominally undoped as well as doped with Cr<sup>3+</sup> ions, have been synthesised by the solid-state reaction method and characterised in detail using powder XRD and luminescence techniques.

The obtained results demonstrate that the modification of the LiGa<sub>5</sub>O<sub>8</sub> host lattice by the Li excess has a high potential for tuning and improving the PersL and TSL properties of undoped and Cr<sup>3+</sup>-doped material. The most striking thing is that the Li excess allows to get a quite efficient blue-emitting persistent phosphor based on the undoped Li<sub>1+x</sub>Ga<sub>5</sub>O<sub>8</sub> spinel.

**Acknowledgements:** The work was supported by the Polish National Science Centre (project no. 2024/53/B/ST11/01108), the Ministry of Education and Science of Ukraine (project DB/GALIO no. 0125U001768).

[1] M. Jia, X. Zhang, X. Yang et al., *J. Mater. Chem. C* 9 (2025) 4616-4625.

[2] A. Karabut et al., Tuning the crystal structure, optical band gap and persistent luminescence performance of Cr<sup>3+</sup>-doped LiGa<sub>5</sub>O<sub>8</sub> spinel by adding aluminum and indium, *to be published*.

# corresponding author: karabut@ifpan.edu.pl