

|                           |  |
|---------------------------|--|
| <b>Project name, IRN</b>  | <b>AP09057946</b> – Spectroscopic studies of functional materials based on perovskites and garnets doped with Ln <sup>2+</sup> , Ln <sup>3+</sup> , Ln <sup>4+</sup> , Ln <sup>4+</sup>  |
| <b>Completion date</b>    | 01.02.2021-31.12.2023  |
| <b>Project supervisor</b> | Zhanturina Nurgul, PhD, associated professor   |
| <b>Report</b>             | The project aims to synthesize and further study the luminescent properties of perovskites and garnets doped with Ln <sup>2+</sup> , Ln <sup>3+</sup> (lanthanum ions in the 2+ and 3+ oxidation States) for use as phosphors and new photovoltaic devices. It is planned to register extensive spectroscopic characteristics – radiation spectra, excitations, high-pressure spectroscopy, time-resolving spectroscopy, and photoconductivity. Analysis of luminescent processes with Fermi statistics should provide new information that is usually overlooked. In particular, two-layer structures of dielectrics that have p-n junction properties can provide new electroluminescent or photoelectric devices. Since dielectrics have a band gap of about 5-10 eV, electroluminescence associated with p-n transitions can cover a wide energy and spectral region.  |
| <b>Relevance</b>          | The project aims to synthesize and further study the luminescent properties of perovskites and garnets doped with Ln <sup>2+</sup> , Ln <sup>3+</sup> , Ln <sup>4+</sup> (lanthanum ions in the 2+ and 3+ oxidation States) for use as phosphors and new photovoltaic devices. It is planned to register extensive spectroscopic characteristics – radiation spectra, excitations, high-pressure spectroscopy, time-resolving spectroscopy, and photoconductivity. Analysis of luminescent processes with Fermi statistics should provide new information that is usually overlooked. In particular, two-layer structures of dielectrics that have p-n junction properties can provide new electroluminescent or photoelectric devices. Since dielectrics have a band gap of about 5-10 eV, electroluminescence associated with p-n transitions can cover a wide energy and spectral region.                     |
| <b>Purpose</b>            | To synthesize functional materials based on perovskites and garnets doped with Ln <sup>2+</sup> , Ln <sup>3+</sup> with further investigation of their spectroscopic characteristics, analysis of the nature of the glow centers and consideration of the possibility of their use for lighting and photovoltaic.  |
| <b>Expected results</b>   | <ul style="list-style-type: none"> <li>• synthesis of single-crystal films of garnets, perovskites and orthosilicates doped with Ln ions with various oxidation states, obtained by solid-state reaction (SSR) and liquid-phase epitaxy;</li> <li>• characteristics of the obtained materials, including structural and spectroscopic studies;</li> <li>• understanding the formation of luminescence centers associated with lanthanide ions in 2+, 3+, and 4+ oxidation states (Ln<sup>2+</sup>, Ln<sup>3+</sup>, and Ln<sup>4+</sup>) in dielectric matrices;</li> <li>• investigation of the effect of joint alloying with other monovalent cations of alkali and transition metal ions on the Fermi energy in the materials under study;</li> <li>• conducting photoconductivity experiments that determine the location of excited states of Ln ions and traps relative to the conduction band.</li> </ul> |
| <b>Research group</b>     | Supervisor – Main researcher: Zhanturina Nurgul, PhD, associated professor, H index = 6 (Author ID in Scopus –   |

|  |  |
|--|--|
|  | <p>55588115900; ORCID - 0000-0001-9540-6334).<br/> <a href="https://www.scopus.com/authid/detail.uri?authorId=55588115900">https://www.scopus.com/authid/detail.uri?authorId=55588115900</a></p> <p>Myasnikova Lyudmila, c.ph.-m.s., associated professor, H index=5 (Author ID в Scopus – 16481268100; Researcher ID - O-9697-2017; ORCID - 0000-0003-3326-7206).<br/> <a href="https://www.scopus.com/authid/detail.uri?authorId=16481268100">https://www.scopus.com/authid/detail.uri?authorId=16481268100</a></p> <p>Sergeyev Daulet, c.ph.-m.s., professor, H index=8 (Author ID в Scopus – 55237792800; Researcher ID - O-3783-2017; ORCID - 0000-0001-7426-3039).<br/> <a href="https://www.scopus.com/authid/detail.uri?authorId=55237792800">https://www.scopus.com/authid/detail.uri?authorId=55237792800</a></p> <p>Aimaganbetova Zukhra, PhD, H index=5 (Author ID in Scopus – 56305678700).<br/> <a href="https://www.scopus.com/authid/detail.uri?authorId=56305678700">https://www.scopus.com/authid/detail.uri?authorId=56305678700</a></p> <p>Saryev Otegen – c.t.s., Assoc professor, Hirsch index h = 4 (Author ID in Scopus - 55355882800)<br/> <a href="https://www.scopus.com/authid/detail.uri?authorId=55355882800">https://www.scopus.com/authid/detail.uri?authorId=55355882800</a></p> <p>Tadeusz Liesnewski –PhD, University of Gdansk (Gdansk, Poland), Institute of experimental physics, H-index -15 (Author ID in Scopus – 57073704100 ).<br/> <a href="https://www.scopus.com/authid/detail.uri?authorId=57073704100">https://www.scopus.com/authid/detail.uri?authorId=57073704100</a></p> <p>Assel Istlyaup – PhD Student, H-index -1 (Author ID in Scopus – 57211115630).<br/> <a href="https://www.scopus.com/authid/detail.uri?authorId=57211115630">https://www.scopus.com/authid/detail.uri?authorId=57211115630</a></p> |
| <b>Results</b>                                 | <p>Samples of yttrium aluminum garnets doped with lanthanum, cerium and europium ions by solid-phase method were synthesized; perovskite films were obtained by liquid-phase epitaxy. The spectra of radiation and absorption of the obtained materials are recorded. The structural characteristics of yttrium aluminum garnets are also modeled on computer programs.</p>  |
| <b>Publications in scientific publications</b> |  |