

The main objective of the research carried out under this project is to study the phenomenon of broadband laser induced emission (LIE) and accompanied photocurrent generated from pure and lanthanide doped GaN and AlN nanocrystalline ceramics and thin films semiconductors in both visible and infrared regions. We can anticipate that LIE spectra of GaN and AlN nanoceramics and thin films may be tuned by excitation power and supplied electric field. The laser induced broadband emission is recently intensively investigated in different nano- and microcrystalline rare earth materials. Until now, most of studies were performed for lanthanide doped dielectric nanocrystalline compounds. Much less attention was focused on semiconducting materials. The gallium nitride GaN is an important wide band-gap (3.4 eV) semiconductor compound for modern electronics. Pure and lanthanide doped GaN and AlN semiconductors were selected for the implementation of this research project. It is well known that semiconductors, and GaN in particular, is a very interesting material that have attracted the attention of the scientific community around the world for many years in various fields of science. The number publications on GaN has been growing steadily since the beginning of the 20th century. Its popularity is also evidenced by the fact that in 2020 over 6,500 papers about this material were published (Scopus.com). Over the last years it has been proven that the method of GaN preparation strongly determines its properties and application possibilities. It turned out that it can be used in solar cells, high sensitivity UV detectors, flexible electronic devices or high electron mobility transistor. Despite the fact that there are so many publications on GaN in the literature, to the best of our knowledge there is only one paper considering high power density infrared laser induced broadband luminescence generation from this semiconductor.

The obtained materials (pure and lanthanide doped) will be characterized in detail in terms of structure and morphology and their influence on the spectroscopic properties of LIE in both visible and near infrared range. Additionally, measurements as a function of the excitation power density and the pressure surrounding the sample will be performed. The research will include also photoconductivity measurements. The study will be extended by investigation of the influence of different light sources on emission properties. Furthermore, the metal nitride thin films (pure and lanthanide doped) will be fabricated. The influence of different sputtering conditions on the thin film growth process will be examined. The spectroscopic measurements will involve studies of dependence of LIE intensity on several material parameters such as absorption coefficient, film thickness, dopant type and concentration. Moreover, investigation of the dynamics and mechanisms of the LIE process will be studied by monitoring the change in material properties (including electric conductivity, reflectivity, temperature, etc.). It allow to track the dynamic response of the materials under LIE process and establish relations between LIE intensity and the material responses. After detailed analysis, we will be able to distinguish the factors that contributing to the LIE intensity.