

SURFACE ENGINEERING BY LASER BEAM IN PRISTINE AND PROTON IRRADIATED GaN

Mykolas Strigūnas¹, Jevgenij Pavlov¹, Tomas Čeponis¹

¹Vilnius University, Faculty of Physics, Institute of Photonics and Nanotechnology, Lithuania
mykolas.strigunas@ff.stud.vu.lt

Gallium nitride (GaN) is widely employed in optoelectronic and high-power electronic applications due to its wide bandgap, high breakdown field, and robustness in harsh environments [1]. Nevertheless, both native and radiation-induced defects are known to strongly influence its optical and electrical performance. In particular, proton irradiation is known to introduce vacancy-related and deep-level defects, which significantly alter carrier lifetime, recombination dynamics, and conductivity, posing critical challenges for GaN-based devices operating in radiation-rich environments. Previous studies have shown that thermal annealing can partially modify or anneal irradiation-induced defects in GaN; however, such processes lack spatial selectivity and require high global temperatures. In contrast, laser beam processing is considered a localized and contact-free approach to surface engineering, enabling precise energy delivery and potentially distinct defect-modification mechanisms compared to conventional thermal treatments [2].

In this work, a systematic study of laser-induced surface modification in both pristine and proton-irradiated GaN layers is proposed. The effects of laser-matter interaction on defect-related optical and electronic properties are intended to be investigated. By comparing laser-processed and unprocessed regions, the feasibility of laser irradiation as a controllable tool for defect engineering or partial damage mitigation in irradiated GaN is to be explored. Optical characterization techniques, including microwave photoconductivity and time-integrated photoluminescence, are planned to be employed to probe changes in carrier dynamics and defect activity. This study is intended to contribute to the understanding of laser-based surface engineering of GaN and its potential role in tailoring material properties for radiation-tolerant devices. The results will be presented at the conference.

[1] T. Čeponis et al., "Combined techniques for recovery of radiation damaged detectors," *Materials Science in Semiconductor Processing*, vol. 168, p. 107863, Sep. 2023, doi: 10.1016/j.mssp.2023.107863.
[2] Y. Jiang, H. Tan, and Y. Zhao, "Improving Optical and Electrical Properties of GaN Epitaxial Wafers and Enhancing Luminescent Properties of GaN-Based Light-Emitting-Diode with Excimer Laser Irradiation," *Symmetry*, vol. 13, no. 10, p. 1935, Oct. 2021, doi: 10.3390/sym13101935.