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RESEARCH OF NON-EQUILIBRIUM CHARGE CARRIER DYNAMICS IN GAN FILMS WITH VARYING IMPURITY DENSITIES

Mantas Auruškevičius[1], Kazimieras Nomeika[1]

[1]Institute of Photonics and Nanotechnology, Vilnius University, Lithuania
mantas.auruskevicius@ff.stud.vu.lt

Gallium nitride (GaN) is a wide bandgap III/V semiconductor, widely used in manufacturing blue light-emitting diodes and high-power electronic components. Its qualities, such as high breakdown electric field, thermal conductivity and electron mobility make it a great material choice for designing small, high power electronic devices [1]. Naturally, further research on this semiconductor might reveal ways to fine-tune the qualities of this material to better suit its uses. This research aims to investigate how equilibrium carrier density, mobility, and certain parameters of GaN film growth affect the dynamics of non-equilibrium charge carriers.

In this research, seven thin GaN films (2,3-2,6 μm thick) were tested using the light-induced transient grating technique (LITG). These films were grown on sapphire using the metalorganic chemical vapor deposition method (MOCVD), but had varying growth parameters, such as the flow of ammonia, temperature, and reaction chamber pressure. Additionally, electron density and mobility were determined in all samples using the Hall effect measurements. All LITG measurements were carried out using a femtosecond laser "PHAROS" (wavelength 1030 nm, pulse duration 250 fs, pulse frequency 30 kHz), an optical parametric system "ORPHEUS" (together with a non-linear crystal for generating the 355 nm pump beam) and a transient grating spectrometer "HARPIA|TG", made by "Light Conversion".

The results have shown that the measured diffusion coefficient increases in all samples with the pump beam intensity. This can be linked to the degeneracy of the charge carrier plasma [2]. Additionally, five out of seven samples showed longer charge carrier lifetimes at higher excitation intensities, which could be explained by the saturation of defect states and slower non-radiative recombination [3]. After this, diffusion coefficient, length and charge carrier lifetime values were taken at low (20 $\mu J/cm^2$), medium (80 $\mu J/cm^2$) and high (~300 $\mu J/cm^2$) sample excitation intensities and these values were used to compare the samples. The comparison showed, that higher diffusion coefficients were measured in samples with lower equilibrium electron densities and higher electron mobilities. Lastly, samples grown at higher reactor pressures and higher ammonia flow have shown overall higher measured diffusion coefficients, charge carrier lifetimes and diffusion lengths.

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