PLASMONIC PROPERTIES OF DEGENERATELY GE-DOPED CUBIC GAN

E. Baron[a], M. Feneberg[a], R. Goldhahn[a], M. Deppe[b] and D.J. As[b]

[a]Institut für Experimentelle Physik, Otto-von-Guericke-Universität Magdeburg, Germany
[b]Department Physik, Universität Paderborn, Germany

The optical properties of highly-doped zincblende GaN (c-GaN) are investigated. Using germanium, free electron concentrations (n) exceeding 10^{20}cm^{-3} can be achieved while maintaining high structural sample quality [1]. Thin films were deposited by plasma-assisted molecular beam epitaxy on 3C-SiC quasi-substrates. Similar to the case of wurtzite GaN [2], they were studied comprehensively by emission and absorption related optical techniques. Spectroscopic ellipsometry yields the complex dielectric function (DF) of c-GaN from the mid-infrared into the deep ultraviolet spectral region. The transverse optical phonon mode and free carrier concentration dependent plasma frequencies are obtained from the IR-DF. Combined with Hall-effect data, we find a pronounced increase of the effective electron mass with n mirroring the non-parabolicity of the conduction band. The onset energy of interband absorption is determined by the fundamental band gap for lower n and blue-shifts due to phase-space-filling for increased electron density. Quantification of this so-called effective Burstein-Moss shift is possible when taking into account the counteracting band gap renormalization effect and the momentum dependence of the effective electron mass. Photoluminescence spectra reveal a blue-shift of the main recombination feature consisting of a donor-acceptor-pair band at doping levels below the degeneracy limit and a free-electron recombination band above. The lineshape fitting yields parameters emphasizing the values for gap renormalization and band filling obtained from DF.

Keywords: cubic GaN; effective mass; non-parabolicity; transition energy

References

[1] M. Deppe, J.W. Gerlach, D. Reuter, D.J. As, Physica Status Solidi B 254 (2017) 1600700.
[2] M. Feneberg, K. Lange, C. Lidig, B. Garke, R. Goldhahn, E. Richter, C. Netzel, M. Neumann, N. Esser, S. Fritze, H. Witte, J. Bläsing, A. Dadgar, A. Krost, Physical Review B 90 (2014) 075203.