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Magnetic resonance studies of the Mg acceptor in thick free-standing and thin-film GaN[1]

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Mg, the only effective p-type dopant for the nitrides, substitutes for Ga and forms an acceptor with a defect level of about 0.16 eV. The magnetic resonance of such a center should be highly anisotropic, yet early work employing both optically detected magnetic resonance (ODMR) and electron paramagnetic resonance (EPR) spectroscopies revealed a defect with a nearly isotropic g-tensor. The results were attributed to crystal fields caused by compensation and/or strain typical of the heteroepitaxially grown films. The theory was supported by observation of the expected highly anisotropic ODMR signature in homoepitaxially grown films in which dislocation-induced non-uniform strain and compensation are reduced. The talk will review EPR measurements of thin films and describe new work which takes advantage of the recently available thick free-standing GaN:Mg substrates grown by hydride vapor phase epitaxy (HVPE) and high nitrogen pressure solution growth (HNPS). Interestingly, the films and HVPE substrates exhibit characteristically different types of EPR signals, and no EPR response could be induced in the HNPS substrates, with or without illumination. In the heteroepitaxial films, a curious angular dependent line-shape is observed in addition to the nearly isotropic g-tensor characteristic of the Mg-related acceptor. On the other hand, the free-standing HVPE crystals reveal a clear signature of a highly anisotropic shallow acceptor center. Comparison with SIMS measurements implies a direct relation to the Mg impurity, and frequency-dependent EPR studies demonstrate the influence of the anisotropic crystal fields. Overall, the measurements of the thick free-standing crystals show that the Mg acceptor is strongly affected by the local environment.

[1]The ODMR was performed by Evan Glaser, NRL and the free-standing Mg-doped HVPE crystals were grown by Jacob Leach, Kyma Tech. The work at UAB is supported by NSF Grant No. DMR-1308446.