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X-ray Spectroscopy of InN heavily irradiated with He J.D. DENLINGER, S.X. LI, R.E. JONES, K.M. YU, J.W. AGER III, W. WALUKIEWICZ, E.E. HALLER, Lawrence Berkeley National Lab, HAI LU, W.J. SCHAFF, Cornell University — We show that irradiation of InN with 2 MeV He ions produces a highly conducting n-type material. Electron concentration saturates at about 4×10^{20} cm^{-3} for the ion dose of 800 μC. Nitrogen K-edge soft x-ray absorption (XAS) and emission (XES) spectroscopy is used to investigate modifications to the conduction band (CB) and valence band (VB) electronic structure of InN containing these very high concentrations of free electrons and defects. XAS, a probe of unoccupied CB states, shows a depletion of states near threshold absorption corresponding to free-carrier filling of the CB, and the creation of two new peaks for irradiated InN that correspond to (*i*) the N-vacancy defect level, and (*ii*) the formation of N-pairs. XES, a probe of occupied states, shows additional emission above the VB maximum, not present in non-irradiated InN, resulting from filled CB states and from elastic scattering. The elastic scattering intensity shows an enhancement for photon excitation at the localized defect level and the non-elastic CB emission is consistent with a band gap narrowing of ≈0.4 eV arising from free-carrier electron-electron and electron-ionized defect interactions. The results provide additional support for previously reported low energy gap and large Burstein-Moss shift in heavily doped InN [1].

[1]J. Wu *et al.*, Phys. Rev. B **66**, 201403 (2002).

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