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**Electronic states in Mn<sup>4+</sup> ions in p-type GaN** BING HAN, Northwestern University, MEL ULMER, BRUCE WESSELS — There is interest in Mn doped GaN for high T<sub>c</sub> ferromagnetic semiconductors. However, Mn in GaN forms deep levels in the band gap. In this study GaN was doped with both Mn and Mg to increase its p-type conductivity. The electronic states of manganese in p-type GaN were investigated using photoluminescence (PL) and photoluminescence excitation (PLE) spectroscopies. A series of sharp PL lines at 1.0 eV is observed in codoped GaN and attributed to the intra *d*-shell transition <sup>4</sup>T<sub>2</sub>(F)-<sup>4</sup>T<sub>1</sub>(F) of Mn<sup>4+</sup> ions. PLE spectrum of the Mn<sup>4+</sup> [<sup>4</sup>T<sub>2</sub>(F)-<sup>4</sup>T<sub>1</sub>(F)] luminescence reveals intra center excitation processes via the excited states of Mn<sup>4+</sup> ions. PLE peaks observed at 1.79 and 2.33 eV are attributed to the intra-d-shell <sup>4</sup>T<sub>1</sub>(P)-<sup>4</sup>T<sub>1</sub>(F) and <sup>4</sup>A<sub>2</sub>(F)-<sup>4</sup>T<sub>1</sub>(F) transitions of Mn<sup>4+</sup>, respectively. In addition to the intra shell excitation processes, a broad PLE band involving charge-transfer transition of the Mn<sup>4+/3+</sup> deep level is observed, which is well described by the Lucovsky model. As determined from the onset of this PLE band, the position of the Mn<sup>4+/3+</sup> deep level is 1.11 eV above the valence band maximum, which is consistent with prior theory using *ab initio* calculations. Our work indicates 4+ is the predominant oxidation state of Mn ions in p-type GaN:Mn when the Fermi energy is less than 1.11 eV above the valence band maximum.

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