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Surface and Bulk Properties of InN

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InN presents challenges and opportunities uncovered during the last 3 years. The bandgap of 0.65eV is much smaller than UV bandgaps for GaN or AlN. InN shares similar chemical and radiation resistant properties of these other wurtzite III-nitrides. In contrast, control of InN electrical conductivity is significantly more challenging. The greatest difference is seen in band bending at the free surface. In place of surface depletion, InN exhibits surface accumulation of electrons at sheet densities of 3-5x1013 cm-2 accompanied by a large surface electric field. The valence band to Fermi level energy difference is found to be 1.2eV (XPS) to 1.5eV (EELS,CV). Undoped InN is n-type. Electron densities are below donor impurity densities and fall with increased thickness. A large dislocation density, which falls with thickness, may play a role in creating the bulk electrons. Low mobility electron transport occurs in defective regions near the lattice mismatched interface with GaN or AlN buffer layers, while low defect density regions have mobility exceeding 2000 cm2/Vsec with non-degenerate carrier densities near 1x1017 cm-3. Electron effective mass is 0.045m0 in the minimum of a non-parabolic gamma conduction band. Velocity-field relations from single particle spectroscopy show velocity overshoot and negative differential mobility. THz wavelength radiation from short pulse laser excitation is generated from the surface of InN and GaN/InN interfaces due to large electric fields. InN electro-chemical sensing occurs by surface chemical interaction with InN surface electron accumulation. P-type doping of InN and GaInN with Mg is inferred by temperature variable conductivity, but surface electron conductivity dominates net Hall polarity.