Resonant Luminescence of Bound Exciton \( (A_0, X) \) and Electron Transport Observed in Zno Grown by Plasma-Assisted Molecular Beam Epitaxy

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We want to discuss very interesting optical and electrical properties of ZnO based on the observation of radiative recombination and in terms of \( n \) and \( \mu \). High quality ZnO thin films were grown on LT-ZnO/c-Al\(_2\)O\(_3\)(1000) single crystal substrate by oxygen plasma assisted molecular beam epitaxy. The ZnO film deposited at 720 oC showed the full-width at half maximum of -rocking curve for ZnO(0002) diffraction line of 80 arcsec and concentration of \( n=2.5\times10^{17}/\text{cm}^3 \) with the high mobility of \( =105 \text{ cm}^2/\text{Vs} \). From the PL measurement at 10K-300K, one \((D_\alpha, X)\) and two \((A_0, X)\) lines were well resolved at 10 K and were identified as \( I_3, I_{10}, \) and \( I_{11} \) respectively by calculating the activation energy obtained from curve fitting of changing intensity. In particular, great increase of the intensity \( I_{10} \) in PL at 50 K was observed and be reasoned by resonance due to the excitation of exciton bound neutral acceptor energy level. From the temperature dependent Hall measurement (\( T\)-Hall), it was found that mobility increased from 30 K to 130 K \( \text{(maximum)} \) and then decreasing and \( T \) vs. \( T \) was fitted by the solving the Boltzmann transport equation using Rode’s method. From the results, at lower temperature region mobility strongly depended on both dislocation density and compensation ratio \( N_A/N_D \)(ratio of acceptor to donor concentration) and at high temperature the polar optical phonon scattering was regarded as main scattering factor. By the analyzing \( n \) vs. \( T \), one donor level of 36 meV for 60K-110K and the other for 110K-300K was obtained. The electron transport and the origin of two shallow donors in undoped high quality ZnO thin film will be discussed.