Abstract Submitted
for the MAR07 Meeting of
The American Physical Society

Origin of high-density two-dimensional electron gas in ZnO/ZnMgO heterostructures. SHIGEHIKO SASA, TETSUYA TAMAKI, KAZUYUKI HASHIMOTO, KAZUYA FUJIMOTO, KAZUTO KOIKE, MITSUAKI YANO, MASATAKA INOUE, Osaka Institute of Technology — We performed a self-consistent calculation of electronic states in ZnO/ZnMgO multiple quantum wells (MQWs). In ZnO/ZnMgO MQWs, the charges induced by spontaneous and/or piezoelectric polarizations at the heterointerfaces play an important role in determining the optical properties. By comparing the optical transition energies between the calculations and experiments, the polarization charge density was determined. In addition, the band bending effects caused by ionized impurities in the structure were found to be crucial for wider ZnO well thicknesses. Therefore, the electronic states in ZnO/ZnMgO MQWs was calculated by changing the thickness of the ZnO layer, Lw (1-8 nm), the sheet polarization charge,σ, and donor concentrations in the ZnO, Nw, and in the ZnMgO, Nb. We also calculated the two-dimensional electron gas (2DEG) concentration in a thick ZnO layer grown on a ZnO (5 nm)/ZnMgO (5 nm) MQW buffer layer by using the same parameters in order to validate the calculation. The 2DEG concentration was successfully explained by the calculation. The calculation indicates that the 2DEG concentration is mainly determined by the donor concentration in the ZnMgO barrier layer.

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Date submitted: 19 Nov 2006 Electronic form version 1.4