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Oxygen Plasma Effect on AlGa_N/Ga_N HEMTs Structure Grown on Si Substrate

**Dong Hyeok Seo, Sung Min Kang, Dong Wha Lee, Du Jin Ahn, Hee Bin Park,
Youn Jun Ahn, Min Soo Kim, Yu Kyeong Kim, Ho Jae Lee, Dong Hun Song,
Jae Hee Kim, Jin Su Bae, Hoon Young Cho**

Department of Physics, Dongguk University

We investigated oxygen plasma effect on defect states near the interface of AlGa_N/Ga_N High Electron Mobility Transistor (HEMT) structure grown on a silicon substrate. After the plasma treatment, electrical properties were evaluated using a frequency dependant Capacitance-Voltage (C-V) and a temperature dependant C-V measurements, and a deep level transient spectroscopy (DLTS) method to study the change of defect densities. In the depth profile resulted from the temperature dependant C-V, a sudden decrease in the carrier concentration for two-dimensional electron gas (2DEG) nearby 250 K was observed. In C-V measurement, the interface states were improved in case of the oxygen-plasma treated samples, whereas the interface was degraded in case of the nitrogen-plasma treated sample. In the DLTS measurement, it was observed the two kinds of defects well known in AlGa_N/Ga_N structure grown on sapphire substrate, which have the activation energies of 0.15 eV, 0.25 eV below the conduction band. We speculate that this defect state in AlGa_N/Ga_N on the silicon substrate is caused from the decrease in 2DEG's carrier concentrations. We compared the various DLTS signals with filling pulse times to identify the characteristics of the newly found defect. In the filling pulse time range under the 80 us, the activation energies changed as the potential barrier model. On the other hand, in the filling pulse time range above the 80 us, the activation energies changed as the extended potential model. Therefore, we suggest that the found defect in the AlGa_N/Ga_N/Si structure could be the extended defect related with AlGa_N/Ga_N interface states.

Keywords: Oxygen-plasma effect, Defect, DLST, Deep level transient spectroscopy, 2DEG, Two-dimensionanl electron gas, HEMT, High mobility electron transistor