

IT-006

Effects of CF₄ Plasma Treatment on Characteristics of Enhancement Mode AlGa_N/Ga_N High Electron Mobility Transistors

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In this study, we study the effects of CF₄ plasma treatment on the characteristics of enhancement mode (E-mode) AlGa_N/Ga_N high electron mobility transistors (HEMTs). The CF₄ plasma is generated by inductively coupled plasma reactive ion etching (ICP-RIE) system. The CF₄ gas is decomposed into fluorine ions by ICP-RIE and then fluorine ions will effect the AlGa_N/Ga_N interface to inhibit the electron transport of two dimension electron gas (2DEG) and increase channel resistance. The CF₄ plasma method neither like the recessed type which have to utilize Cl₂/BCl₃ to etch semiconductor layer nor ion implantation needed high power to implant ions into semiconductor. Both of techniques will cause semiconductor damage.

In the experiment, the CF₄ treatment time are 0, 50, 100, 150, 200 and 250 seconds. It was found that the devices treated 100 seconds showed best electric performance. In order to prove fluorine ions existing and CF₄ plasma treatment not etch epitaxial layer, the secondary ion mass spectrometer confirmed fluorine ions truly existing in the sample which treatment time 100 seconds. Moreover, transmission electron microscopy showed that the sample treated time 100 seconds did not have etch phenomena. Atomic layer deposition is used to grow Al₂O₃ with thickness 10, 20, 30 and 40 nm. In electrical measurement, the device that deposited 20-nm-thickness Al₂O₃ showed excellent current ability, the forward saturation current of 210 mA/mm, transconductance (gm) of 44.1 mS/mm and threshold voltage of 2.28 V, ION/IOFF reach to 108. As IV concerning the breakdown voltage measurement, all kinds of samples can reach to 1450 V.

Keywords: CF₄ plasma, Al₂O₃