Seminar Announcement

Growth of High resistive GaN and AlGaN/AlN/GaN HEMT on SiC substrate by MOCVD

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ABSTRACT

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The III-nitride based high electron mobility transistor (HEMTs) structures are very promising for high-power and high-frequency power applications due to it is high breakdown voltage, high mobility, high carrier density and high thermal stability properties. High-resistive (HR) or semi-insulating (SI) GaN template layers are important for electronic devices in order to satisfy complete channel pinch-off, proper drain-source current saturation, low loss at high frequencies, and low cross-talk between adjacent devices. But, it is well known that GaN exhibits high unintentional n-type doping levels. One effective way, to decrease n-type doping levels and to obtain HR or SI-GaN, is to dope with acceptor-like impurities, like iron (Fe), magnesium (Mg) or carbon (C) atoms during growth of the GaN template layers. But, firstly, Fe and Mg doping has a memory effect and difficult to control doping levels. Secondly, trapping effect of the acceptor-like impurities in the vicinity of 2DEG channel causes current collapse in the device characteristics. On the other hand, in the III-nitride growth process by MOCVD, carbon impurity commonly exists in the materials due to the use of metal-organic precursors. Another source for carbon atoms may be TaC coating of the susceptor and the graphite-made

insulation used around the susceptor. Tuning of the growth conditions in MOCVD growth system changes the carbon levels in GaN layer. In this method, growth conditions such as reactor pressure, growth temperature, growth rate, V/III ratio have all been shown to have some effect on the resistivity of GaN layer.

The Sapphire, Si or SiC substrates are widely used for GaN-based HEMTs growth. But, the higher thermal conductivity and lower lattice mismatch to GaN properties of the SiC makes it is highly chosen substrate for nitride based microwave or power transistors compared to sapphire or Si.

By using residual carbon doping method, HR-GaN templates and AlGaN/AlN/GaN HEMTs were grown on 2″ SI 6H-SiC substrate. The sheet resistance of the GaN templates was tuned by using tuneability of residual carbon doping in MOCVD growth. By optimizing the growth conditions the GaN layer on SI 6H-SiC susbstrate with sheet resistance of 10^{10} Ω/sq was achieved. The AlGaN/AlN/GaN HEMTs were grown using HR GaN templates. The room temperature carrier density and mobility was measured as $1x10^{13}$ cm^{-2} and 1950 cm^2/Vs, respectively.