K-Band AlGaN/GaN Power HFETs

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Recent advances in the GaN-based HFETs has showed the strong potential of this technology for the next-generation microwave power applications. While most of power performance of these devices has been focused in the X-band, there has not been much work done at higher frequencies. In this study we report power performance of GaN HFET's at K-band. The epitaxial layers for fabrication of GaN HFET's were grown by plasma assisted MBE on semi-insulating SiC wafers. The structure of devices reported in this study consists of, starting at the substrate, nucleation layer, 2 μm thick GaN layer and of strained AlGaN Schottky barrier layer. The described HFET structure consistently yields room temperature 2DEG Hall effect mobility of over 1300 cm^2/Vs and electron sheet charge density of $1.3x10^{13}$ cm^{-3}. The Ti/Al/Ni/Au metalization process is used to form source and drain contacts. The source-drain separation of devices is 2 μm. The ohmic contact resistance extrapolated from TLM patterns is 0.5 ~ 0.7 Ω-mm. The 0.15 μm long T-shaped gate fingers were defined using e-beam lithography. The two terminal reverse-bias gate-to-drain breakdown voltage of 40 ~ 50 V was measured at gate at V_{ds} = 10 V, V_{gs} = -5.5 V. From S-parameter data, an extrinsic current-gain cutoff frequency (f_τ) of 85 voltage of 40 ~ 50 V was measured at gate at V_{ds} = 10 V, V_{gs} = -5.5 V. From S-parameter data, an extrinsic current-gain cutoff frequency (f_τ) of 85 GHz and a maximum frequency of oscillation (f_{max}) of more than 100 GHz were extrapolated. The on wafer power measurements at 20 GHz were performed using an active load-pull system. The power performance of 0.1 mm (2x50μm) device biased at Vds = 20 V and Id = 80 mA is shown in Figure 3. The device has a gain of 10.7 dB in a linear region and a gain of 6.3 dB at peak efficiency. The measured continuous wave (CW) output power density of 6.6 W/mm with associated power added efficiency (PAE) of 35% is, to the best of our knowledge, the highest reported to date for a field effect transistor at this frequency. This is also the best combination of the output power density and PAE reported for a GaN HFET in the K-band. Our results clearly show that of GaN HFET's have strong potential for power applications at K-band frequencies and beyond.

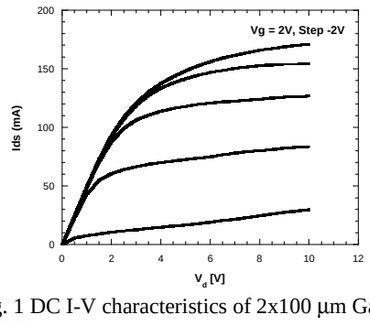

Fig. 1 DC I-V characteristics of 2x100 μm GaN HFET