High Performance GaN/AlGaN HEMTs

A. G. Baca, R. D. Briggs, J. W. Johnson, C. Monier, A. A. Allerman, C. C. Mitchell, J. R. Wendt, R. J. Shul, F. Ren, and M. G. Armendariz

GaN HEMT structures are being investigated for possible applications in high power and high temperature electronics. Abrupt AlGaN/GaN interfaces can be used to form HEMT quantum-wells with higher sheet charge than conventional GaAs- and InP-based materials. The high breakdown field achievable in GaN allows these devices to be biased at high drain bias for increased power output without unduly sacrificing the electron transit time. Both the high breakdown field and high sheet charge contribute to GaN's ability to produce the highest solid-state power density, which promises to extend the realm of solid-state power and offer new types of system miniaturization. Many efforts, including the present work, are underway to extend the frequency range at which this solid-state power is feasible.

GaN HEMT structures have been grown on sapphire substrates by MOCVD. DC current density approaching 1A/mm has been achieved for HEMTs with gate length ranging from 0.12 μm to 0.5 μm. Maximum transconductance of 207 mS/mm was achieved. An aluminum concentration of 20% in the AlGaN charge transfer layer was used in this study. From s-parameter measurements, f_t of 64 GHz and f_{max} of 87 GHz were extracted. The characterization of these devices and their small signal modeling will be presented. Analysis of the technical challenges in further scaling of the devices will be presented