Pulse Testing of AlGaN/GaN HEMTs

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AlGaN/GaN HEMTs are promising candidates for high power solid-state power amplifiers at frequencies of 2GHz and above. Their excellent material properties including high breakdown field, high charge density, and good transport have led to the development of transistors with highest power density of any semiconductor material. For example, we have developed AlGaN/GaN HEMT technology based on epitaxial growth on SiC substrates and have demonstrated power density in excess of 5 W/mm. However, most aspects of GaN technology are far from mature. High dislocation density materials, other growth issues, unoptimized processes, and high electric fields are factors that lead to problems observed in AlGaN/GaN HEMTs. In particular, current collapse in the I-V characteristics of HEMTs and degradation from DC or RF stress are of particular concern. Current collapse is often attributed to traps generated during material growth or to surface traps generated in processing. The causes of degradation are poorly understood at this time. In either case, it is important to identify specific causes of non-ideal HEMT behavior in order to address their root cause.

Power amplifier evaluation using on-wafer load-pull tests are quite useful to gauge the quality of GaN materials and processes. However, the feedback cycle can be long and delay progress. DC and static s-parameter testing are quicker and can be useful in some aspects of optimizing devices, processes, and materials, but do not in many cases give a useful prediction of power amplifier performance. Pulsed I-V testing can provide both rapid feedback and a useful prediction of power amplifier performance. In this talk we will present a material and process evaluation methodology based on pulsed I-V testing. Examples of both MOCVD growth and process optimization to minimize current collapse will be presented.

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