Invited Talk

Commercially Viable GaN-on-Si based Power Device Developments at International Rectifier

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A brief review is provided of the current status of commercially viable GaN-on-Si based high electron mobility (HEMT) power devices at International Rectifier in the voltage rating range of 20 to 600 V [1]. Several seminal achievements which have been accomplished over the last 10 year effort will be highlighted, including the crack free growth of thick (5 um) III-N epitaxy on large diameter silicon substrates and the development of silicon (CMOS) foundry compatible device fabrication processes. Comparisons to the structure, underlying physics and performance characteristics of state of the art silicon based alternatives will be presented, including the role of the absence of laterally resolved p-n junctions in GaN HEMTs on breakdown voltage behavior and ratings. The ability to fabricate robust large area 20 to 600 V rated devices, capable of processing nearly 1000 A/cm^2 is demonstrated. Measured results for the long term reliability of 30, 100 and 600 V rated devices for up to 10,000 hours each under standard high temperature stress conditions will be presented. The absence of such previously suggested reliability limiting mechanisms such as "reverse piezo-electric effect" and threading dislocation induced breakdown is discussed.

Advantages of GaN based power HEMTs over incumbent silicon based alternatives in several power conversion applications from low voltage dc-dc (e.g. 12 V to 1 V) for high performance electronic loads to high fidelity class-D audio amplification and high efficiency ac-dc for platinum (> 92 %) and titanium (>94 %) rated power supplies in server and telecom systems, as well as compact, lightweight motor drive inverter systems used in appliances (< 1 kW) to electric vehicle drive trains (> 20 kW) are demonstrated. Prospects for truly revolutionary power conversion systems based on high power integrated circuits, made possible by the lateral nature of GaN HEMTs are presented. The implications of the availability of cost effective highly reliable, robust, high current capable GaN based power devices, from 20 to 600 V, on the enablement of wide scale adoption of efficient loads for electronic systems and the subsequent potential for significant reduction of world wide energy consumption will be discussed.

References

[1] See International Rectifier library of GaN based power device data at www.irf.com