Electrical and physical characterization of AlGaN/GaN power HEMTs after thermal storage*

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In this study, AlGaN/GaN power HEMTs have been physically and electrically characterized before and during long term heat treatment. Actually AlGaN/GaN HEMTs are already leading the performance race for radiofrequency applications and they are foreseen to replace Si devices in power conversion circuits. The here-studied transistors are GaN-on-Si HEMTs with a gate periphery of 12 mm, a drain saturation current IDSS of 7A (600mA/mm) and a transconductance gm of 1S (80mS/mm).

Devices have been stressed during 640 hours at 250°C in a furnace with periodic electrical and Photon-Emission Microscopy (PEM) characterizations. Thus, several parameters have been extracted from pulsed-IV measurements such as ON-state resistance RDSon, gm, maximum saturation current IDSSmax, maximum gate current at OFF-state high drain-source voltage IGmax and pinch-off voltage VP. No degradation of RDSon, gm, IDSSmax, and VP has been noticed showing that electron transport properties have not been affected and suggesting the 2DEG channel is not degraded. On the other hand, a huge increase in IGmax has been measured on both stressed devices as compared to an unstressed device. This evolution has been correlated with PEM characterizations exhibiting several extra luminescence spots appearing with an evolution corresponding to the IGmax degradation.

n order to investigate the origin of this degradation, several TEM samples have been prepared with FIB, using lift-out technique. One sample (A) has been extracted from an unstressed device and two from an aged device (B and C). B is extracted in the viscinity of an extra luminescence spot and C is picked from a non-emissive area. Area B and C show a large amount of crystallographic defects whereas they remain less abundant in A.

Finally, the origin of the luminescence observed in PEM measurements and its comparison to electrical and physical characterizations is discussed.

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