PERFORMANCE

R&D APPLICATIONS

ATRON METROLOGY

INFLUENCE OF ELECTRON-IRRADIATION AND X-RAY ON DC ELECTRICAL PERFORMANCES OF GaN POWER HEMTs

200 KeV - 3.5 MeV

X-rays and ebeam

LOW CURRENT - HIGH STABILITY

EFFECTS OF A DIRECT ELECTRON-BEAM AND/OR X-RAYS ON THE ELECTRICAL CHARACTERISTICS OF DIFFERENT AlGaN/GaN OR AlInN/GaN POWER TRANSISTORS.

As GaN-based transistors are intended to be used in military, nuclear industry, and space applications, it is imperative to study their electrical behaviors in extreme conditions. Then, it is very important to study the influence of electrons and X-rays on dc electrical performances of GaN power transistors.

Gallium nitride-based high electron mobility transistors (HEMTs) have attracted much research interest and have emerged as promising candidates for high-power applications at microwave frequencies like satellite communications or radar applications. The most important advantages of these devices are the large energy bandgap difference and high electron velocity, which lead to a high density of sheet charge and high current density.

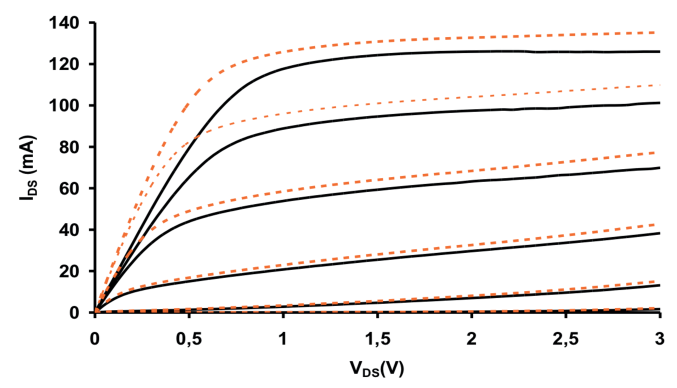

Fig. 1 :IDS(VDS) characteristics of AlGaAs/InGaAs PHEMTs before (solid line) and after a gamma radiation using a dose of 42.8 krad(GaAs) (dotted line).

These properties, combined with the high thermal stability, make GaN-based devices suitable for high-power, high-frequency applications. They also have the potential to exhibit extremely high radiation hardness. These devices can be more radiation tolerant than gallium-arsenide-based devices or silicon-based devices. Systems employing GaN devices will be deployed in space, where they are exposed to both particle and electromagnetic radiation. Hence, it is very important to understand the radiation tolerance of GaN-based electronic devices.

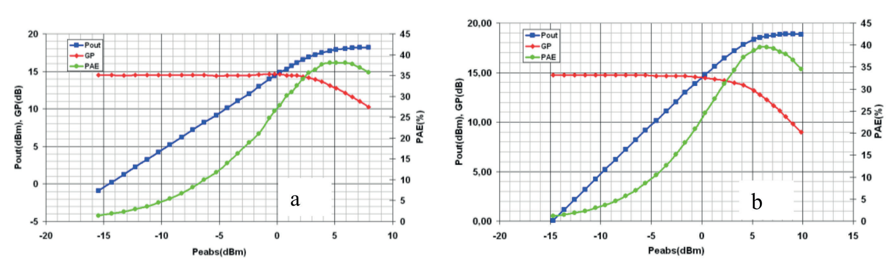

Fig. 2 : Evolution of the output power, power-added efficiency, and power gain versus absorber input power for a non-irradiated device (a) and for a device after a gamma radiation dose of 0.85 Mrad(GaAs) (b).

Generally, in previous studies, the device degradation is observed after a proton irradiation as a decrease in the maximum transconductance and in the drain saturation current and then as a decrease in power. In a recent past, we have observed the opposite for AlGaN/GaN HEMT structure irradiated with a thermalized neutrons fluence. We have also shown the possibility to modify the electrical traps density present in the semiconductor structure of GaN-based transistors.

Besides, the irradiation can also have a beneficial effect on the electrical characteristics of GaAs-based Field Effect Transistors. Thus, we have also shown the possibility to improve DC and RF electrical performances of AlGaAs/InGaAs PHEMTs by using low gamma radiation dose and low neutron fluence. Thus, an increase in the drain current of 10 % (Fig. 1) and a rise in the maximum output power density of 18 % (Fig. 2) have been induced by the irradiation.

Then, it is very interesting to study the effects of a direct electron-beam and/or X-rays on the electrical characteristics of different AlGaN/GaN or AlInN/GaN power transistors. To guaranty the results, we need an electron-beam and x-rays with a high stability in term of current and voltage. The new electrons' accelerator proposed by ATRON seems to be a very powerful instrument useful for our future research works.

Bertrand Boudart
Professeur UNICAEN
GREYC UMR CNRS 6072
145 chemin de la crespinière
50130 Cherbourg-en Cotentin, France
+33(0)2.33.01.40.06
bertrand.boudart@unicaen.fr

Yannick Guhel
Maître de Conférences UNICAEN
GREYC UMR CNRS 6072
145 chemin de la crespinière
50130 Cherbourg-en Cotentin, France
+33(0)2.33.01.40.06
yannick.guhel@unicaen.fr

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