CARAPACE: Advanced Characterization of Power Semiconductor Devices

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EQUIPMENTS

LABORATORIES: G2ELAB, NEEL

PRINCIPAL INVESTIGATORS : Pierre Lefranc, Pierre-Olivier Jeannin, **Alexis Derbey** (equipment supervisor), David Eon, Etienne Gheeraert, Julien Pernot

CARAPACE characterization platform was designed accordingly to multidisciplinary requirements between high voltage, high temperature range, optical and electrical constraints. Its purpose is to accurately measure the static performances of novel power semiconductor devices and their integrated functions (Fig. 1). New materials for power electronics such as diamond (C) or Gallium Nitride (GaN) are pushing the limits of the current state of the art in terms of current density, on-state losses and dielectric breakdown voltage, operating temperatures and high frequency power applications. This new situation imposes new requirements around the characterization at high voltage, high temperature and high frequency that were not available in the Grenoble area. In addition, the necessary insulation levels and associated robustness rely on new solutions for gate signal transfer such as optical control.

In addition to a hardware consolidation, this platform aims to bring together teams working on these new components, gathering common needs around a high-performance equipment. This platform supervised by G2ELab involves one team at NEEL and two teams at G2ELab, working closely with CEA-Leti.

CARAPACE is based on a Janis station feed by an Agilent B1505 curve tracer with additionnal modules (Fig. 2). The main ratings of the equipment are:
- 6 probe needles (2 coax / 2 triax / 1 HV / 1 optical)
- Vacuum (5×10-4 mbar),
- Temperature: -200°C to > 300°C,
- Electrical: 3000V max (pulse and DC), and 2.5 A max (pulse).

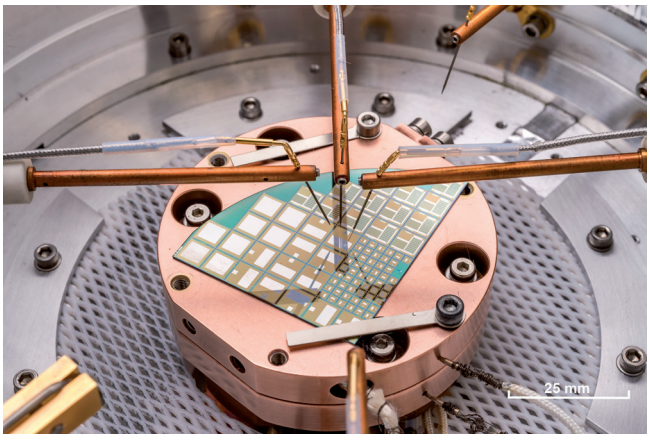

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Fig. 1: Characterization of power semiconductor devices.

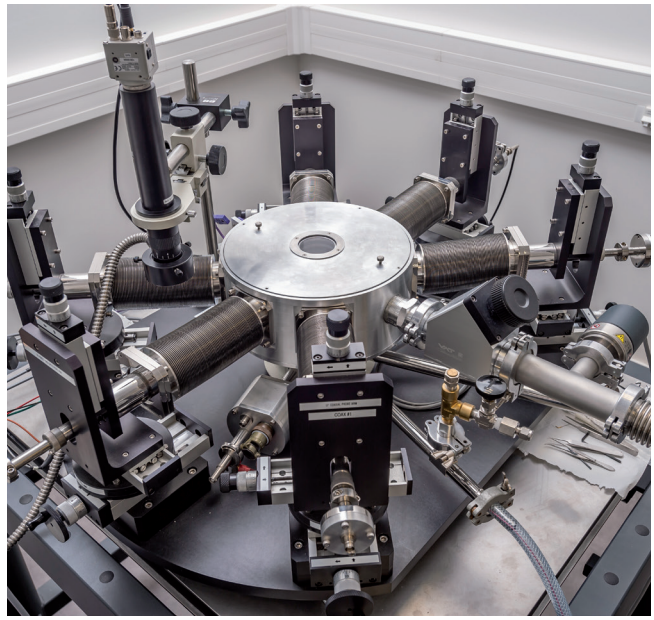

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Fig. 2: Global view of the Janis station.

OUTCOMES

[1] Above 2000V breakdown voltage at 600 K GaN-on-silicon high electron mobility transistor, Phys. Status Solidi 213, 873 (2016).

[2] Deep-depletion mode boron doped monocrystalline diamond metal oxide semiconductor field effect transistor, IEEE Electron Device Lett. 38, 1571 (2017).

[3] Integrated temperature sensor with diamond Schottky diodes using a thermosensitive parameter, Diam. Relat. Mater. 78, 83 (2017).

[4] Realization and Characterization of Instrumented Power Diode with Aluminum RTD Sensor – Application to Thermal Impedance Evaluation, EPE Journal 27, 106 (2017).

Oral presentations:
MRS Spring meeting, Phoenix, USA, 2016.
ICDCM, Montpellier, France, 2016.
NDNC, Cairns, Australia, 2017.
MRS Fall meeting, Boston, USA, 2017
SGE, Nancy, France, 2018.

Collaborations: CEA-Grenoble, Grenoble, France - IEMN, Lille, France - AIST, Tsukuba and Osaka, Japan – NTNU, Trondheim, Norway.

Awards: PhD Award for A. Marechal, ICDCM Conference, Madrid, 2014.

PhD students: J. Letellier (2016-), C. Masante (2016-), K. Driche (2015-), L. Oluwasayo (2015-), G. Perez (2015-), D. Colin (2014-2017), T. Thanh Pham (2014-2017), I. Ka (2014-2017), B. Letowski (2013-2016), G. Regnat (2013-2016), S. Madassamy (2013-2016).

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