Interest of using a micro-meter spatial resolution to study SiC semi-conductor devices by Optical Beam Induced Current (OBIC)

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Interest of using a micro-meter spatial resolution to study SiC semi-conductor devices by Optical Induced Current (OBIC)

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UV Laser can be used to generate electron-hole pairs into Wide Band-Gap (WBG) semiconductors. In the space charge region, the electric field drives the collected carriers and a current, so-called **Optical Beam induced Current (OBIC)**, can be measured. The induced current is directly related to the electrical field in the device. **The OBIC, is a non-destructive characterization technique, which has been previously successfully used to characterize High Voltage (HV) SiC devices [1,2,3,4].**
In order to fully benefit of the advantages provided by SiC and to avoid premature breakdown of the high voltage devices, it is mandatory to have efficient peripheral protections such as MESA and/or JTE. The OBIC characterization can help the technology computer-aided design (TCAD) and the device process to optimize the efficiency of the periphery protection by analyzing the electric field distribution in the structure and especially at the junction periphery. **In this talk, we will present an in-house testbench called micro-OBIC which will allow us to characterize SiC high voltage (HV) PiN diodes (10 kV class) with a micro-meter spatial resolution.**

A laser emitting UV at 349 nm is used to generate electron-hole pairs into SiC epilayer close to the top surface. In order to reduce the laser beam spot size, we developed a testbench represented in figure 1.a) The laser beam intensity is first controlled by a set of neutral density filter, before passing through a beam expander. Finally, the laser spot is focused by a microscope objective. The spot size is estimated around 1-2μm. The HV device under test (DUT) is fixed on a X,Y,Z motorized stage and the DUT can be moved under the laser beam focus point. Induced current is then measured with a Source-Measure Unit (SMU). The DUT can be reverse biased by applying voltage thanks to the SMU.
2D (X,Y) micro-OBIC scans were performed on HV PiN diode. The PiN diode was fabricated on a 4H-SiC wafer using a 110 μm thick epilayer with a doping concentration of 7.10^{14} cm^{-3}. These diodes are protected by a MESA and a JTE of 400 μm length as shown in Figure 1.b)
Figure 2b and 2c. compared the optical image and the OBIC signal (at 0V) of the same part of the diode. The OBIC signal is null in the electrode, reached a peak (around 120nA) in the MESA region, then decreases to lower value to stay almost constant (around 30nA) in the whole JTE region. Figure 3 represents a 3-D view of the OBIC signal with a reverse biased at 100V. The reverse biased induced an increase of the OBIC peak to 200nA and of the signal in the JTE region to 130nA. Moreover the microscopic spatial resolution of the micro-OBIC testbench highlights very small features in the MESA region, which were not observable with previous lower spatially resolved OBIC testbench [4]. Some defaults in the JTE region are visible too. To better understand the physical origin of these fine structures and defaults, these experimental results will be compared to OBIC simulations and coupled with other characterization technics such as scanning electron microscopy (SEM) or micro-Raman spectroscopy.

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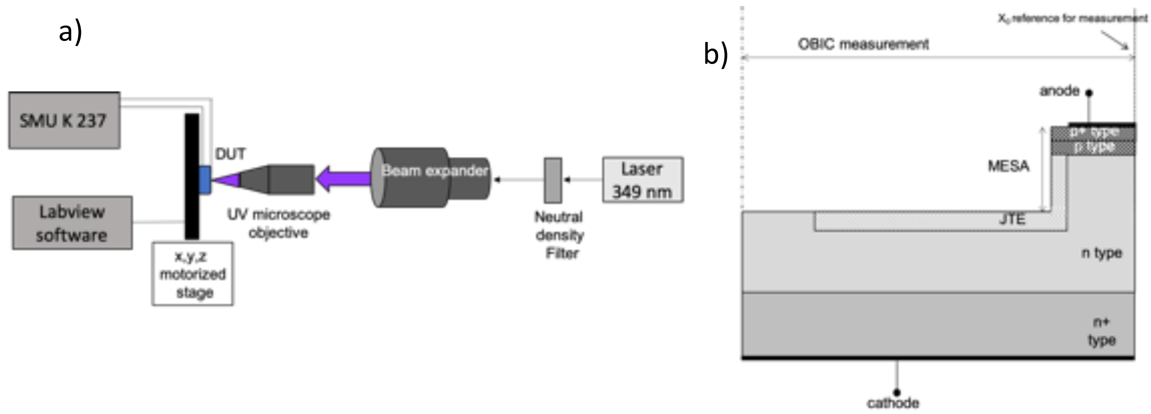

Fig. 1a). Schematic representation of the micro-OBIC testbench.
Fig. 1b) schematic representation of the SiC HV PiN diode.

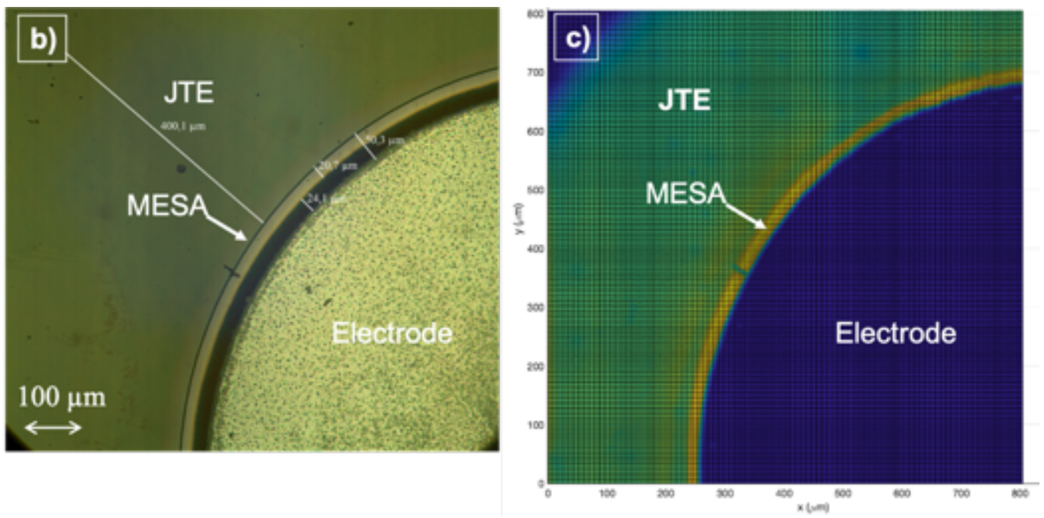

Fig. 2a) Optical image of the diode (top view), microscope objective x50.
Fig. 2b) micro-OBIC 2D-scan of the SiC HV PiN diode at 0V.

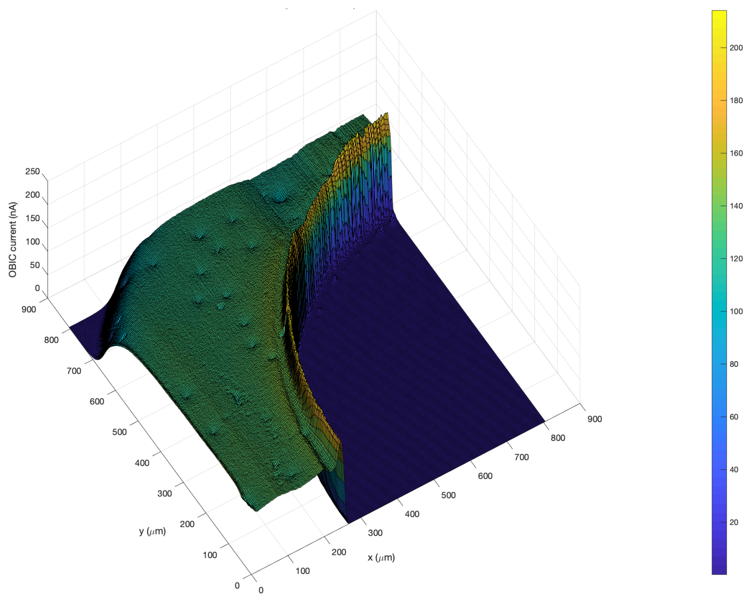

Fig. 3. Micro-OBIC 2D-scan of the SiC HV PiN diode reverse biased at 100V.