

SiC On Insulator as substrate for power Schottky diodes

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Recently INFINEON™ and other companies announced the market introduction of their SiC Schottky rectifiers in the range of 600 V several amperes. This announcement allows the design of power electronic systems with a cooling effort drastically reduced than required before, which is a great improvement for electronics in terms of cost and efficiency. However SiC components are still checked by an expensive substrate supplying and by the small 3 inches size of the SiC wafers.

SiCOI substrate presents the capability of large sized handle wafers, allowing the utilization of 4,6 or 8 inches facilities. In addition the fabrication of numerous SiCOI substrates requires a single SiC substrate as illustrated in figure 1. This later point should make SiCOI a low cost SiC substrate. The purpose of this article is to give the first electrical characteristics of a Schottky rectifier on that promising substrate.

The substrate features and the diode processing are described thereafter. The SiCOI substrate is obtained by Smart-Cut® process [1], which is presented figure 2. The SiC layer is N doped with an electrical resistivity compatible with the manufacturing of a SiC high voltage device. A cross-sectional view of the diode is shown figure 3.

The cathode electrode is made by sputtered Ni on an N⁺ doped area. The high field edge protection is achieved by a Boron implantation of 10¹⁵ cm⁻² at 30 keV [2]. Schottky contacts are made by deposition and patterning of sputtered Ti. Finally a polyimide is deposited and opened on contact areas.

According to simulation results diodes are designed to sustain 450 V. Forward bias current is limited by heat generation, which decreases the carrier mobility. Nevertheless, as shown in figure 4, a 0,3 A/cm current density is assumed for 1,5 V forward bias. Simulations are carried out with MEDICI software, with most of Ruff SiC parameters [3] and Konstantinov impact ionisation modelling [4].

Devices characterizations will be presented in this final paper.

[1] Di Cioccio L., "Silicon carbide on insulator formation using le smart cut process", electronics letters, 1996, vol 32, n°12, p1144-1145

[2] Itoh Akira, "Excellent reverse blocking characteristics of high-voltage 4H-SiC Schottky rectifiers with boron-implanted edge termination", IEEE EDL, 1996, Vol 17, N°3, p139-141

[3] Ruff Martin, "SiC Devices: Physics and Numerical simulation", IEEE T-ED, 1994, Vol 41, N°6, p1040-1054.

[4] Konstantinov AO, "Ionisation rates and critical fields in 4H silicon carbide", Appl. Phys. Lett, 1997, Vol 71, N°1, p90-92.

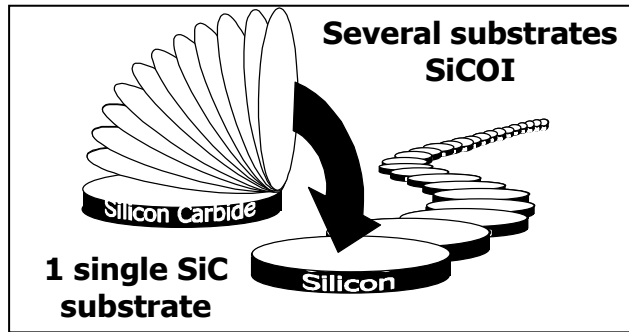


Figure 1 - Simple scheme illustrating the fact that numerous SiCOI substrates can be fabricated with only one SiC substrate

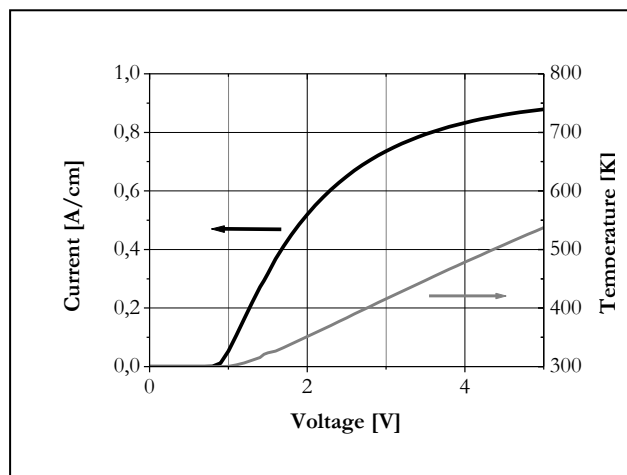


Figure 4 - Current voltage and temperature voltage characteristics, in a case of a 0,25 Kcm²/W thermal resistance placed at the bottom of the diode structure

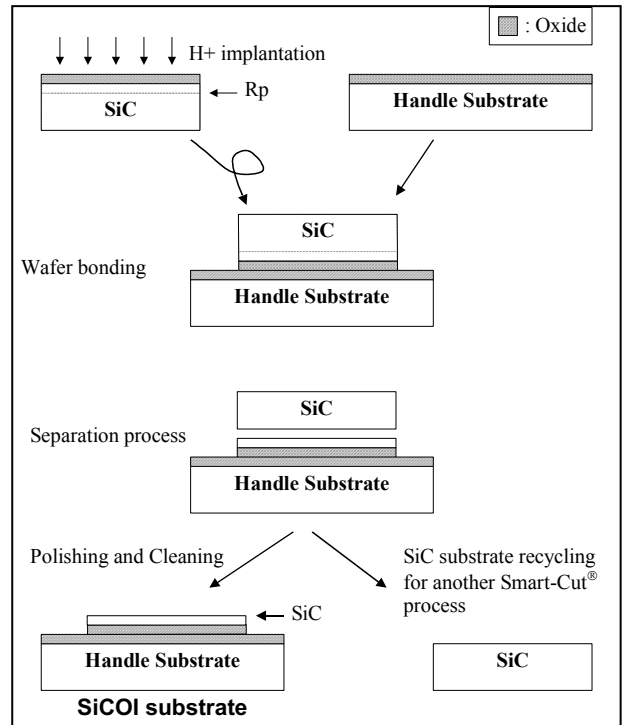


Figure 2 - Fabrication process for SiCOI substrate. This is an adaptation of the SOI Smart Cut[®] process for Silicon Carbide

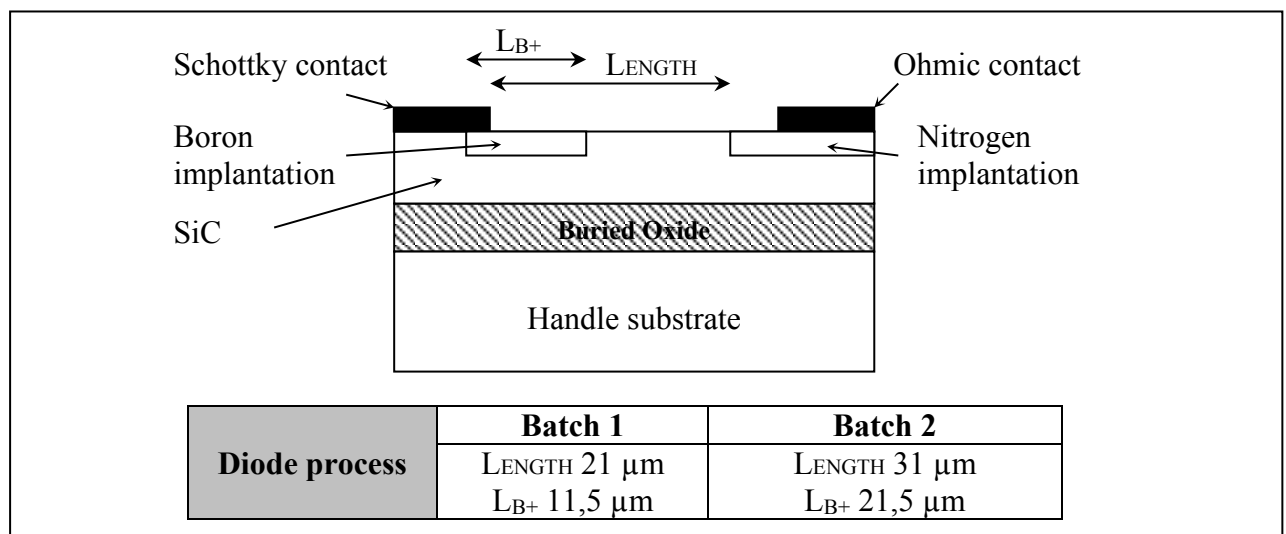


Figure 3 - Schottky diode structure on SiCOI substrate