

High voltage (6kV) diamond TMBS diode design

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This paper presents the first steps in the design of a 6 kV diamond TMBS (Trench MOS Barrier Schottky) diode. The specificity of the TMBS structure lies in the trench covered by a uniform layer thickness of insulator and metal. By applying a reverse bias, a space charge region extends vertically under the Schottky contact but also laterally on both sides of the mesa width due to the MOS effect (Fig-1). The connection of the two lateral deserts shields the Schottky contact from strong electric fields and prevents device breakdown. During the first step of the design, an analytical study based on the TMBS operating principle is carried out in order to obtain an equation that describes the variation of the mesa width ' m ' according to several electrical properties (electric field, bias voltage and insulator permittivity) and technological parameters (insulator width ' t_{ins} ' and doping concentration ' $EpiDop$ ') (Fig-1). This equation allows specifying the range of variation of the TMBS technological parameters for an optimal operating mode and that will be used in the 2D TCAD simulation. The choice of the insulator of the TMBS proves to be crucial to achieve high breakdown voltage in diamond layer and to reach the targeted electrical performances. In the second step of the design, 2D TCAD simulation results show the relationship between device's electric characteristics and critical technological parameters. The analysis of these simulated results reveals that the desired breakdown voltage of the TMBS is obtained for a higher doping concentration compared to an ideal Schottky diode and thus decreasing the on-state resistance. The final 6kV TMBS diode structure will be presented with the appropriate methodology for its design.

Keywords - Power devices, diamond, TMBS, MOS, Schottky, Breakdown voltage, Insulator, TCAD simulations.

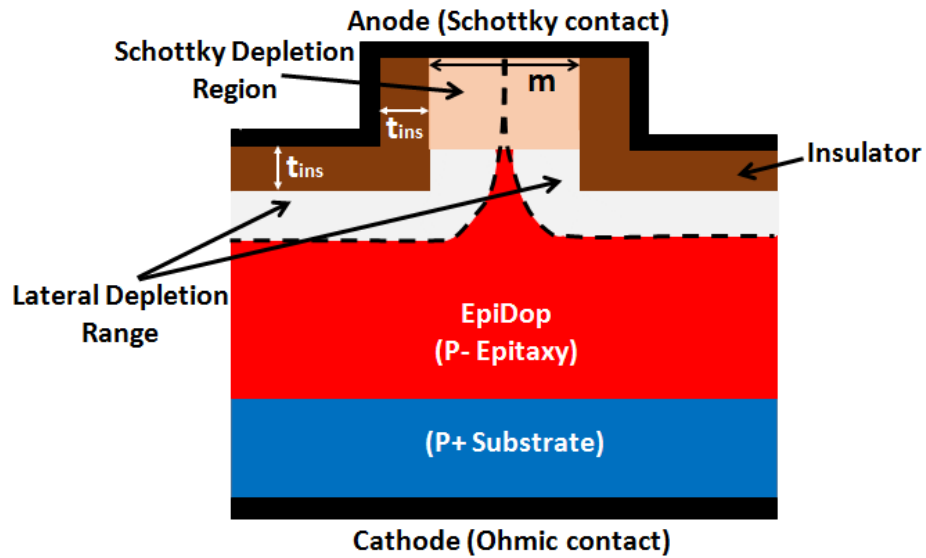


Fig-1: Schematic Cross Section of a TMBS Diode and lateral depletion range of p diamond layer under reverse bias.