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Silvaco-based evaluation of 10 kV 4H-SiC MOSFET as a solid-state switch in narrow-pulse application

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Key requirements for a solid state switch in a fast switching pulsed power circuit include high blocking voltage, high current conduction and fast switching. The wide bandgap properties of silicon carbide has enabled the development and commercialization of high voltage MOSFET whose steady state and transient characteristics meet the requirements for narrow pulse width applications. Even thought SiC MOSFETs are gaining acceptance in the field of high power electronics, commercial viability and reliability has been demonstrated for devices under 2 kV out of which 1.2 kV appears to be the blocking voltage of choice. Typical pulsed power applications like plasma initiation and high-energy LASER require operating voltages in the order of several kilovolts. The development of a multi-kilovolt SiC MOSFET for fast switching pulsed power application would require detailed analysis of the device switching characteristics. Since Metal Oxide Semiconductor (MOS) capacitances play a crucial role in determining the switching characteristics of the MOSFET, it becomes critical to have a comprehensive understanding of the device capacitance and its effect on the gate driver requirements for narrow-pulse switching. In this research, a 2D model of 4H-SiC MOSFET was developed using Silvaco ATLAS TCAD software and simulated for its steady state and AC characteristics. The device was designed for 10 kV blocking voltage and 100 A/cm² drain current density. The C-V data for the SiC MOSFET was generated via Silvaco AC simulation and the data was used to mathematically estimate the gate drive requirements for the device under fast switching.

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