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Evaluation of High Voltage SiC PiN Diode with Robust Field Edge Termination as an Opening Switch Device

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Silicon Carbide is a very promising material for high pulsed power and high frequency devices with ultra-fast switching requirements; however, despite SiC devices showing encouraging results that may qualify them as ultrafast switches in high power pulse systems, many more design and processing issues need to be addressed. Specifically, a premature surface breakdown at SiC DSRD (SOS) chip edges is still a major hurdle to clear, as reported in the literature [1,2]. In this work, 6.5kV SiC PiN diodes with robust field edge termination design developed at GE Global Research Center for energy conversion systems are tested in a fast switching mode. Diode pumping circuit designed for Si opening switches were used in this test. Despite the mismatched pumping, the SiC diodes demonstrated fast switching, achieving a 10-90% risetime of approximately 5 ns.
This is an encouraging result given that these devices were designed for use as high voltage rectifiers without any design optimization and consideration given to operation as an opening switch.
Mixed mode simulations using the actual test circuit parameters and the PiN diode device structure were employed to analyze the impact of field edge termination parameters on transient characteristics of switching waveforms. Recommendations for the optimization of the SiC PiN diodes to be used in fast-switching mode will be discussed in the full paper.
[1] P. Ivanov and I. V. Grekhov, "Subnanosecond Semiconductor Opening Switch Based on 4H-SiC Junction Diode,"Mater. Sci. Forum, vol. 740–742, pp. 865–868, Jan. 2013
[2] V. A. Kozlov , I. A. Smirnova , S. A. Moryakova and A. F. Kardo-Sysoev, "New generation of drift step recovery diodes (DSRD) for subnanosecond switching and high repetition rate operation", Power Modulator Symposium, and High Voltage Workshop, pp. 441-444, 2002

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