Contribution ID: **216** Type: **Oral Presentation**

High Current Switching Capabilities of a 3000 V SiC Thyristor for Fast Turn-on Applications

Wednesday 6 July 2016 15:30 (15 minutes)

Triggered solid state devices capable of holding off more than 1 kV and surging multiple kA of current are increasingly a viable alternative for pulsed power applications that previously required triggered spark gap switches or other devices based on gaseous electronics. For a number of pulsed applications requiring high surge current at low to moderate pulse repetition rates, Thyristor devices offer superior performance compared to MOSFETs or IGBTs; however, Thyristors typically feature slower turn-on time, which is governed by a diffusion limited process referred to as the base transit time. This relatively slow turn on transient results in high losses when hard-switching on timescales below 1 μs. The high saturated electron drift velocity and superior critical electric field strength offered by a wide band gap material has potential to reduce turn-on time and increase efficiency, potentially reducing losses on time scales below 1 μs to an acceptable level. Results will be presented from an investigation designed to evaluate the pulsed capabilities of a 6 mm x 6 mm, 3 kV, 35 A asymmetrical Thyristor fabricated on ultra-low micropipe density 4H-SiC 4”wafers by GE Global Research Center. Previous investigations into the pulsed capability of these devices have been focused on microsecond duration pulses at moderate peak currents of 200-800 Amperes and di/dt less than 1 kA/μs. Initial results show that these devices are capable of surging up to 3 kA at 25 kA/μs with a current rise time of 150 ns. Switching efficiencies up to 2.5 times higher than Si have been recorded, indicating that failure mechanisms related to local heating in the resistive drift layer of the device may be less prevalent compared with Si devices.

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Session Classification: Oral 3

Track Classification: Opening, Closing, and Solid State Switches