Silicon Carbide Power Device Performance Under Heavy-Ion Irradiation

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Abstract: Heavy-ion induced degradation and catastrophic failure in SiC power MOSFETs and diodes are examined to provide insight into the challenge of single-event effect hardening of SiC power devices.

Discussion Cont’d

In silicon power MOSFETs SEE susceptibility by radiation testing is often reduced by elevated temperature and/or by the addition of a dose rate to the single-event test to drive voltage and suppress second breakdown. In two of the SiC power MOSFETs studied here, elevated temperature tests did not impact current degradation or sudden SEB onset, suggesting different fundamental mechanisms are involved in SiC power devices.

Small sample sizes limit the conclusions that can be drawn from data that are not presented in Table II. Silicon carbide power electronics devices are rare or non-existent. Most space applications will require SiC power devices that have been hardened to SEE. All commercial SiC power devices evaluated here exhibited inordinate catastrophic SEE at biases below 60 V of their rated radiation withstand voltage and experienced radiation degradation. Downstream devices such as SiC power MOSFETs and bipolar transistors in front-end electronics may also be subjected to SEE events, which can be deleterious to their functionality. This work was supported in part by the NASA Electronic Parts and Packaging (NEPP) Program, NASA Solar Electric Propulsion Program, the NASA High-Temperature Boost Power Processing Unit Project, other NASA high-risk projects, and the Defense Threat Reduction Agency (DTRA) through the Defense Threat Reduction Agency’s (DTRA) Microelectronics Technology Development (MTD) Program. In addition, we thank Ray Ladbury, Yuval Natan, Stephen Cox, Jim Kliman, and Doug Contreras of NASA-GRC for technical assistance.

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