Progress Towards SiC ASICs for Extreme Temperature and Radiation Environments

Philip Neudeck

NASA Glenn Research Center, Cleveland OH, USA
Neudeck@nasa.gov

Abstract: This presentation describes development and demonstrations of semiconductor integrated circuits (ICs) and ceramic packaging that are arguably the most environmentally durable transistor electronics ever demonstrated. Silicon carbide (SiC) junction field effect transistor-resistor (JFET-R) ICs fabricated by NASA Glenn Research Center with two-level interconnect have successfully operated for over 1 year in 500 °C air-ambient [1,2], 60 days in 460 °C and 9.3 MPa pressure caustic Venus surface environment test chamber [3], and radiation exposure through 7 Mrad(Si) total ionizing dose (TID) and 86 MeV-cm^2/mg heavy ion strikes [4]. Furthermore, these ICs have also demonstrated operation from -190 °C to +812 °C (over 1000 °C temperature span) without significant change in signal (input /output) or power supply voltages [5]. While the operating frequency and functional complexity is far below silicon-based ICs, these SiC application specific ICs (ASICs) are nevertheless becoming capable of providing unique and advantageous harsh-environment circuit functionality without cooling/sheltering overhead. With modest adjustments, the SiC JFET-R fabrication process is compatible with semiconductor mass-production tools and materials. As an initial step towards manufacture, a majority of processing steps to realize the next SiC JFET-R IC prototype wafer run have been outsourced to commercial foundry. It is expected that further upscaling combined with technology transfer to commercial production will lower investment and risk barriers to useful application deployment.

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[4] J. Lauenstein, *et al., 2019 IEEE Radiation Effects Data Workshop*, DOI: 10.1109/REDW.2019.8906528
[5] P. Neudeck *et al., Materials Science Forum* **963**, 813, 2019.