Industrial, Manufacturing & Systems Engineering

April 24, 2019
11:00 AM – 11:50 AM
IMSE 235

Reliability Analysis of Silicon Carbide Power Devices

ABSTRACT

For decades, silicon has been the material of choice for the vast majority of semiconductor devices. However, in recent years, power semiconductor devices made of wide-bandgap (WBG) materials such as silicon carbide (SiC) and gallium nitride (GaN) are increasingly becoming available on the commercial market and are experiencing widespread adoption in many high power and high-voltage applications such as DC-DC converters, inverters, battery chargers, industrial motor drives, and solid-state pulse generators, to name a few. The higher bandgap and inherent thermal properties of the WBG materials allow for advantages over traditional silicon devices including higher blocking voltages, increased switching speeds, physically smaller implementations of application circuits, improved system efficiencies and higher operating temperatures. Despite these clear advantages, the full potential of WBG technology will not be realized until the overall industry confidence in the long-term reliability of WBG devices is increased. To that end, Texas Tech University (TTU), with funding from PowerAmerica, has conducted extensive testing on commercially available SiC MOSFETs and diodes, to determine the overall reliability of these devices as well as any potential issues. TTU developed testbeds for the following tests: high temperature gate bias (HTGB), high temperature reverse bias (HTRB), high temperature operating life (HTOL), time dependent dielectric breakdown (TDDB), short circuit, diode surge current, avalanche, di/dt, dv/dt, and hard switching. The purpose of this presentation is to give an overview of WBG power semiconductor device testing, as well as a discussion of some of the results from the TTU PowerAmerica project.

BIOGRAPHY

Dr. Stephen B. Bayne received his Ph.D, MS and BS degrees in Electrical Engineering from Texas Tech University. After completing his doctoral studies, he joined the Naval Research Lab (NRL) where he was an electronics engineer designing advanced power electronics systems for space power applications. After two and a half years at NRL, Dr. Bayne transferred to the Army Research Lab (ARL) where he was instrumental in developing a high-temperature Silicon Carbide power electronic program. Dr. Bayne was promoted to Team Lead at ARL where he led the power components team which consisted of five engineers. As the Team Leader, Dr. Bayne was responsible for advanced research in high temperature and advance power semiconductor devices for Army applications. Also, he developed internal research and also generated Small Business Initiative Research (SBIR) topics and worked as the Contracting Officer Representative (COR) on several contracts. After one and a half years as Team Lead, Dr. Bayne was promoted to Branch Chief of the Directed Energy Branch where he managed 16 Engineers, technicians and support staff. Dr. Bayne managed a multi-million dollar budget and was responsible for recruiting, development, and performance evaluation of members in the branch. After eight years at the ARL, Dr. Bayne transitioned over to academia where he is currently a Professor at Texas Tech University. His research interests at Texas Tech are Power Electronics, Power Semiconductor Devices, Pulsed Power and Renewable Energy. Dr. Bayne has over 130 journal and conference publications. Dr. Bayne is also a veteran of the Military, where he served four years in the Air Force.