SAND2014-3803C

Test simulation of neutron damage to electronic components using accelerator facilities

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Historically, reactors have been used to test the transient response of electronic systems to displacement damage and ionization. With the diminishing availability of reactor facilities, an ongoing effort exists to use alternative facilities and radiation types, such as light and heavy ions as well as electrons, to simulate the displacement damage of neutrons. The concept of "equivalent" damage between these types of irradiation is a topic of much interest. This paper examines the relations between several measured damage metrics of electronic components after irradiation by reactor neutrons and by ions and electrons generated by particle accelerators. Metrics considered include measured early- and late-time gain degradation in III-V Npn heterojunction bipolar transistors and the type and number of defects as measured in GaAs diodes using deep level transient spectroscopy (DLTS). Reactor facilities used to test electronics include the White Sands Missile Range Fast Burst Reactor (WSMR FBR) and the Sandia National Laboratories Annular Core Research Reactor (SNL ACRR). The ion facility used in this work is the SNL Ion Beam Laboratory (IBL). A 6 MV tandem Van de Graaff and numerous ion sources allow the IBL to provide a wide variety ions and energies. The electron facility addressed is the Little Mountain Test Facility linear accelerator (LMTF LINAC), located at Hill AFB in Utah, operated in electron beam mode. Electron energy levels ranging from 3 MeV to 20 MeV were investigated. Little Mountain has a unique capability among LINACs in that it can provide long pulse widths. Pulse widths can be tailored from 25 nsec to 50 μsec settings with beam currents ranging from 0.1 to 2 Amps. In summary, we will demonstrate that alternate accelerator facilities, such as the IBL and LMTF, have great utility in replacing the use of reactors to test discrete GaAs diodes and transistors when the appropriate damage metrics are selected. We intend to expand the approach of using alternate facilities to circuit applications.