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Radiation Effects Microscopy in Microelectronic Devices Using a Heavy Ion Nuclear Microprobe

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In microelectronic devices exposed to energetic radiation electron-hole pairs are created. The movement of these carriers in an electric field will lead to induced current in the electrodes of the device. While this is the basic mechanism of solid-state particle detectors, this current can lead to detrimental effects in microelectronic devices. This current can induce a variety of Single Event Effects (SEEs) that eventually can cause errors in the normal operation of the device or even the failure of the device. These effects can be catastrophic if they occur in microelectronic circuits installed in satellites and spacecraft when the devices are exposed to high level of radiation. Broad beam test can identify the problems and sometimes qualify the devices for radiation hardness but they are not able to pinpoint which element of the device is responsible for the failure of the circuit. Nuclear microprobes are just the right tools to study the mechanism of these SEEs on the microscopic level and help find mitigation techniques and methods.

In this talk we will review the various SEEs and how a nuclear microprobe can be used to study them. Several examples will be given using this technique to study SEEs. Among them a study on Single Event Burnout in Heterojunction Bipolar Transistors and radiation effects investigations in memristors will be presented. A brief review of effects of displacement damage in microelectronic devices will be discussed.

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