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Ion Electron Emission Microscopy at LNL

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Ion Electron Emission Microscopy (IEEM) at SIRAD, the heavy ion irradiation facility at the XTU Tandem on LNL, is used to obtain micrometric sensitivity maps of electronic devices to Single Event Effects (SEE). The electronic Device Under Test (DUT) is located one millimeter behind a very thin (100 nm) self-standing Silicon Nitride (Si_3N_4) membrane with a 40 nm Au deposition. The secondary electrons extracted by the ions impacting the Au surface normally are collected and the electron emission microscope, a system of electrostatic lenses coaxial with the ion beam, focuses them onto a chevron MCP and a fast phosphor stack. The ion-impact signals, light spots on the phosphor screen, are regenerated by an image intensifier and finally imaged by a high-rate and high-resolution position detector purposely developed for the IEEM system. The Au layer and the thin Si_3N_4 membrane, used to ensure a copious and uniform emission of secondary electrons, are thin enough not to significantly perturb swift ion beams. The SEE detected on the DUT are time correlated with the position of the ion impact reconstructed by the IEEM system and a sensitivity map is thus constructed.

We give a detailed description of the SIRAD IEEM setup in its present configuration, highlighting possible improvements. To this end we briefly describe the varied experience we have had with the IEEM at the SIRAD: (1) the first tests mapping Single Event Upsets (SEU) in a SDRAM memory; (2) a time-resolved Ion Beam Induced Charge Collection (IBICC) experiment with a power MOSFET device to map out regions with different sensitivity to the impinging ions; (3) the SEU sensitivity of a Shift Register used to address the lines of a monolithic pixels detector fabricated in a commercial silicon on insulator technology; (4) a study of the origin of supply current spikes and destructive events in NAND flash memories under heavy-ions by investigating the role of charge-pump capacitors, previously considered the most probable cause of the phenomenon.

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