

Collision cascade and spike effects of X-ray irradiation on optoelectronic devices

Abstract

Bombardment with high energy particles and photons can cause potential hazards to the electronic systems. These effects range from degradation of performance to functional failure, which can affect the operation of a system. Such failures become increasingly likely as electronic components are getting more sophisticated, while decreasing in size and tending to a larger integration. In this paper, the effects of X-ray irradiation on a plastic encapsulated infrared light emitting diode, coupled to a plastic encapsulated silicon infrared phototransistor, with both of them being electrically isolated at ON and OFF modes, are investigated. All the devices are exposed to a total dose of up to 1000 mAs. The electrical parameters of the optoelectronic devices during the radiation exposure and at post-irradiation are compared to the pre-irradiation readings. The findings show that the highest degradation occurs at low dose of exposure; beyond 100 mAs the relative decrease in collector current of the phototransistor is gradually reduced. The most remarkable feature found, is the operational dependence of the bias collector current, indicating a higher degradation for low bias forward current of the light emitting diode. The degradation induced at the forward current of the light emitting diode by X-rays irradiation is almost negligible whereas a decrease of the rate of change in current transfer ratio is significant during the X-ray irradiation. The results show that there is no significant difference between current transfer ratio of ON mode and OFF mode radiation. It is observed that the operating mode of the optoelectronic devices after exposure to 1000 mAs of X-ray irradiation contributes no major variation in the degree of damage.