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Simulation of Synergistic Effects on Lateral PNP Bipolar Transistors induced by Neutron and Gamma Irradiation

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The numerical simulation methods of neutron displacement effects, total dose effects and ionizing/displacement synergistic effects are established in this work. By the use of semiconductor devices simulation software TCAD, numerical simulation of ionizing/displacement synergistic effects on lateral PNP bipolar transistors induced by neutron and gamma irradiation is carried out with the method of changing minority carrier lifetimes, surface recombination velocity and adding charge traps to SiO2 layer. The results indicate that in the lateral PNP bipolar transistors irradiated with gamma rays up to 50 krad(Si) and with neutrons up to 3.0e13 cmˆ(-2), the total ionizing dose effects can enhance the neutron displacement damages and lead to larger gain degradation.

Summary

The simulation results indicate that in the base region of lateral PNP bipolar transistors irradiated with gamma rays and neutrons simultaneously, total recombination rate is larger than the sum of those in the base region of lateral PNP bipolar transistors irradiated with gamma rays and neutrons individually, the total ionizing does effects can enhance the neutron displacement damages and lead to larger excess base current and gain degradation. Therefore, ionizing/displacement synergistic effects on lateral PNP bipolar transistors are not a simply combination of total ionizing does effects and displacement effects, and enough attention should be paid to this phenomenon.

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