Neutron Induced Interface Traps Passivation on Bipolar Transistors

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Abstract

The neutron radiation effect of bipolar GCPNP transistor is studied in China Spallation Neutron Source (CSNS), and the ionization damage characteristics are analyzed by using gate-controlled charge separation method, the degradation characteristics of minority carrier lifetime, oxide trap charge and interface state were obtained, respectively. The effect of displacement damage defect on the charge accumulation of oxide trap is analyzed by using tcad simulation tool. The mechanism of neutron induced interface traps passivation on bipolar transistors is analysed and verified by comparison experiment between the post-neutron irradiated TID effect and the single TID effect in the GCLPNP transistors.

The results show that the damage of neutron displacement has no significant effect on the accumulation of oxide trapped charge, the effect of neutron displacement damage on N_{OX} can be neglected in the level of neutron fluence involved in the study. On the other hand, neutron irradiation can reduce the density of the primary interface traps by passivating, so that the total charge of Si-SiO_2 interface decreases and the peak voltage of the gate scan exhibit positive shift. Neutron irradiation can passivate the primary interface traps of the device, the passivated product is Si-H bond. The effect mechanism of pre-neutron irradiated transistors is verified by TCAD simulation and different order irradiation test. Results show that the pre-neutron irradiated transistors have more serious interface state damage in the subsequent total dose effect. In addition, the gate-controlled sweeping test results show that the coupled effect may occur when the displacement damage and the ionization total dose effect act on the bipolar transistor simultaneously, and lead to the deterioration of the synergistic effect.