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Study on the Total Ionizing Dose Effects of SiGe HBTs Irradiated with 60Co γ Rays

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The characteristic of the dc current gain degradation with dose and current injection level for SiGe HBT during 60Co gamma irradiation are measured and analyzed. Additionally, the typical dc and ac parameters degradation mechanisms are discussed. The experimental results of the dc and ac electronic parameters before and after irradiation are shown to result in the base current Ib, the collector current IC, the dc current gain and the maximum oscillation frequency fmax exhibiting degradation after irradiation. While other electronic parameters including the cutoff frequency fT, the ac current gain |H21| and output capacitance CCBO do not exhibit any significant change compared with those of pre-irradiation.

Summary

The dynamic change of dc current gain of the npn type SiGe HBT during 60Co γ irradiation have been investigated at different injection current levels and the damage constant of dc current gain is affected by the collector current levels. The higher the collector current is, the smaller the damage constant of dc current gain, this phenomenon indicated that improving the device current injection level or bias voltage appropriately may effectively reduce ionizing damage effects. The experimental results of typical dc and ac electronic parameters before and after irradiation showed that the base current Ib, the collector current IC, the dc current gain and the maximum oscillation frequency fmax are degraded after irradiation. While other electronic parameters including the cutoff frequency fT, the ac current gain |H21| and output capacitance CCBO did not exhibit any significant change compared with those of pre-irradiation. The surface effects induced by total ionizing dose of 60Co γ irradiation on SiGe HBT are mainly responsible for the above parameters degradation according to the low energy gamma radiation damage mechanisms.

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