Calculation of Single Event Burnout failure rate for high voltage devices under satellite orbit without fitting parameters

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Abstract

Increase of power bus voltages in spacecraft are expected with the power demand growth. Accordingly, high voltage semiconductor devices in the power supply system will be required to withstand high energy and high flux cosmic ray environment. We propose a new formula to calculate failure rate for power semiconductor devices in space application.

Since the cosmic ray induced failure has been discussed only for power semiconductor devices for sea level applications. Thus the terrestrial failure rate had been calculated based on the empirical model extracted from the terrestrial experiment data. The failure rate calculation formula for satellite orbit condition was proposed, for the first time, from our group.

However, there are two problems. First, calculation accuracy was not sufficiently high due to the assumption that the failure phenomenon at high electric field occurs in the entire device with the same probability. Second, since there was only 300μm –thick silicon data of deposited energy probability, only the failure rate of 300μm i-layer device could be calculated.

We increased the number of TCAD simulation condition, specially, for different the charge deposition position, and propose new formula including the position dependence in the failure rate calculation. The calculation accuracy is improved and new formula become applicable to any breakdown voltage semiconductor devices.