

Business

Overview

Si IGBTs and Si diodes are commonly used in high-voltage power electronics applications such as EV, HEV, railway traction, wind turbine generators, and industrial robots. TCAD simulation has been used for the design and performance optimization of these bipolar devices for over 30 years. Recently, high-precision process simulation is required for these devices to improve their performance. Accurate process simulation is expected. Furthermore, precise modeling for complex carrier recombination physics is also expected to adapt various carrier lifetime control technologies.

In this project, we established calibrated TCAD setups for Hitachi's side-gate high-voltage IGBT (side-gate HiGT⁽¹⁾) and diode. The calibration setups are based on Sentaurus Calibration Workbench, which is designed to increase the value of TCAD by allowing users to rapidly calibrate TCAD models. We also included modeling of electron beam irradiation (EBI) physics for their electron beam irradiation (EBI) process. Eventually, we provided well-calibrated process and device models. The models precisely represent actual device performance, not only DC characteristics but also switching waveforms.

Modeling and Calibration by Sentaurus Calibration Workbench

Sentaurus Calibration Workbench is a tool designed to perform efficient simulations for TCAD simulation tools. It provides evaluation, sensitivity analysis, search, calibration, and machine learning functions. Although Sentaurus Calibration Workbench is a standalone tool, it interacts with Sentaurus Workbench for setting up and running simulations. It utilizes the job scheduler of Sentaurus Workbench to speed up simulations by using distributed heterogeneous computing resources.

Figure 1 shows the structure of the side-gate HiGT. In this project, Sentaurus Calibration Workbench was used initially for the calibrations to reproduce the doping profiles of ion implantation. The profiles of boron, phosphorus, and arsenic were accurately fitted to SIMS measurement results. We performed a search and calibration work for the geometric calibration of the gate structure at the front side and the modeling of melting laser anneal to reproduce the backside impurity profiles.



