Keysight Technologies
IMECAS uses MBP to Create a PDSOI PN Junction Model

Case Study

Challenge

- Accurately model the PN junction in PDSOI technology

Solution

- Proposed a PN junction simulation model based on the PDSOI process
- Model accounts for both the bottom and lateral PN junction
- Model takes into consideration the influence of the voltage bias of the junction on capacitance

Results

- Verified PN junction model using the junction itself and a ring-oscillator

Silicon-on-insulator (SOI) technology is rapidly becoming mainstream due to its lower power, higher speed and higher packing density. The shallow PN junction is used in partially-depleted silicon-on-insulator (PDSOI) technology to resolve the response problem that occurs during total-dose radiation.

Researchers from the Institute of Microelectronics of Chinese Academy of Sciences (IMECAS) have proposed a new simulation model for the PN junction based on SOI. Keysight Technologies' Model Builder Program (MBP) software was used to extract the model parameters. The capacitance-voltage (CV) fitting results of the N+P junction are shown in Figure 1.

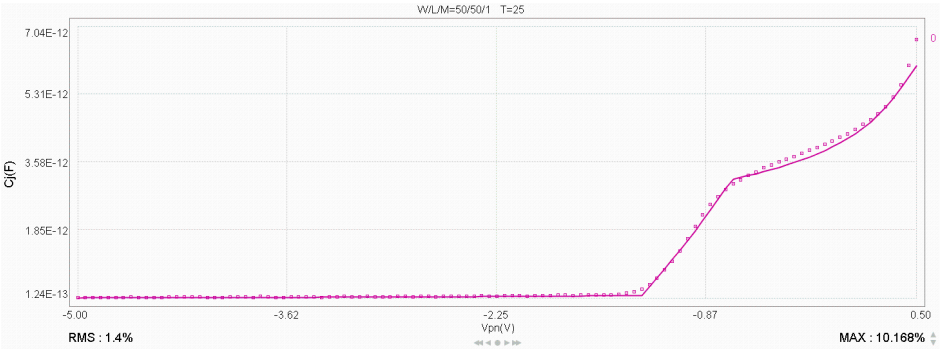

Figure 1. Simulated and measured CV character of the PN junction.

"MBP is the most efficient tool I have used for device modeling. It supports the Verilog-A model well, and the parameters are easy to extract using MBP's optimizers and automated model extraction flows. Because of these capabilities, MBP is a tremendous help in my work."

Jianhui Bu
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Challenge

Utilization of the special PN junction in a device fabricated in SOI technology requires proper modeling. However, the standard diode model is simply not suitable for this task. This model is very different from the PN junction in bulk silicon.

Solution

To eliminate this obstacle, IMECAS researchers proposed a simulation model based on the PDSOI process. Figure 2 shows the measured CV characteristics of the PN junction. Unlike a normal diode, the curve is not smooth. It can be divided into three parts according the value of Vpn (i.e. the X-axis of Figure 2).

The PN junction model was implemented in Verilog-A using the standard diode model. The code was divided into three parts in keeping with the bias of the PN junction. The model is based on the physical mechanism. The parameters are easily extracted using Keysight's MBP software.

Results

The model proposed by IMECAS researchers fits the measured data well, especially in the transition region. This junction model can also be embedded into the MOSFET model.

To verify the model, researchers used a 101-stage ring-oscillator. The measured and simulated periods of the ring-oscillator are shown in the Table.

Table 1. Measured and simulated period.

	Measured per-stage propagation delay	Simulated per-stage propagation delay
101-Stage ring oscillator	511 ps	544 ps

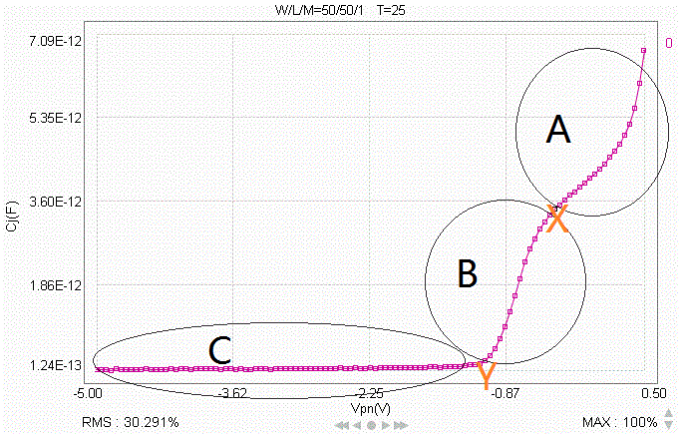

Figure 2. The measured CV characteristics of the PN junction.

More Information

To learn more about how IMECAS creates the PN junction SPICE model using Keysight MBP, go to:

A Simulation Model for the PN Junction Based on SOI

Learn how MBP can help you in device modeling by clicking here for a free trial.

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