TERP'99

Technology & Engineering Research Programme

Title ***Semiconductor Process/Device Simulation with TCAD***

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Abstract

Technology computer-aided design (TCAD) tools have become increasingly popular in aiding new semiconductor technology development. In this project, a simple semiconductor junction diode will be virtually "fabricated" and characterized using TCAD tools. The students will gain practical experience and knowledge in visualizing semiconductor device fabrication and operation.

Objectives

- Exposure to modern semiconductor fabrication processes and devices through a simple example (diode)
- Practical experience in the state-of-the-art computer simulation tools to emulate simplified physical phenomena
- Knowledge in design of experiment (DOE), modeling, and data analysis
- Motivation in carrying out research

Scope

- Reading on general semiconductor processes (such as implantation, diffusion, etc.) and device characterization (such as I–V, C–V, etc.)
- Familiarization with the TCAD tools (such as DOE tool, process and device simulators)
- *Virtual wafer fabrication* (VWF) — simulate the fabrication process of a simple junction diode
- *Virtual device characterization* (VDC) — simulate the electrical (I–V) characteristics of the "fabricated" diode
- Study on the target–variable dependency

Methodology

- *Design conceptualization* — identify the major target parameters and process variables
- *Design implementation* — implement the design to obtain the required target–variable dependency
- *Numerical simulation* — run process and device simulation
- *Data analysis* — analyze and understand the simulated data
- *Physical modeling* — extract physical model parameters from the simulated device

Tasks

- Study the basic diode equation and its I–V characteristics
- Understand the basic process steps to fabricate the diode
- Identify the design *targets* (turn-on voltage, leakage current, ideality factor) and *variables* (implant dose and energy, diffusion time and temperature, substrate doping)
- Design and implement the experiment through DOE and numerical simulation (major task)
- Obtain the target–variable relationship by graphical plots
- Model the numerical data by physical equations
- Document the project and summarize the experience