Web-based Modeling, Simulation, Parameter Extraction, and Characterization for Power Electronics Curriculum

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ABSTRACT

The goal of this work is to provide a set of modeling, simulation, parameter extraction, and characterization WEB-based capabilities for supporting the device component of a power electronics curriculum. The modeling and simulation will introduce new features and capabilities into compact models for power devices, such as modeling device breakdown, leakage, reliability mechanisms, self-heating, and accounting for the temperature dependences of materials parameters. The focus of this work is on GaN-based power devices. The reliability modeling and characterization for these devices [1] revealed different degradation mechanisms are involved at close to room temperature and above 150 °C. The degradation at low temperatures is due to the trap generation. At higher temperatures, degradation mechanisms involve permanent defect creation. The gate leakage at the gate edges was identified as another source of reliability problems. Modeling the gate current involves tunneling, thermionic emission, and surface leakage.[2] Similar issues are important for all other power devices.

For the WEB-based experimentation, we will use Automated Internet Modeling (AIM) Lab dedicated to semiconductor device modeling and characterization.[3] Our lab has been used for courses on semiconductor devices at senior and graduate level. Recently, we incorporated into the AIM-lab You-Tube compatible on-line video feeds, and capabilities for audio and visual collaboration via web messaging. [4] We will also review and compare other WEB-based experimentation facilities including MIT's iLab Shared Architecture (ISA), Lab-on-Web at UniK, Next Generation Laboratory (NGL), and Internet Laboratory (I-Lab).

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[2] S. Karmalkar, D. Mahaveer Sathaiya, M. S. Shur, Mechanism of the Reverse Gate Leakage in AlGaN / GaN HEMTs, Appl. Phys. Lett. 82, 3976-3978 (2003)

[3] Fjeldly, T. A., and Shur, M. S. (2003). *Lab on the Web.* New Jersey, NJ: John Wiley & Sons.

[4] V. Chivukula and M. Shur, Web-based Experimentation for Students with Learning Disabilities, Developments in Engineering Education Standards: Advanced Curriculum Innovations, IGI Global, Editor: Mohammad Rasul (CQ University, Australia), pp. 216-232 (2012).