# TCAD at the SRC

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The Semiconductor Research Corporation (SRC) is a consortium that manages IC manufacturing related research. The membership consists of IC manufacturing companies, their suppliers, and a number of affliated companies. Most of the research is conducted at US universities. Research partnerships exist with various organizations such as SEMATECH, the National Laboratories, NIST, DARPA, the State of New York. The SRC is presently organized into 7 science areas: (1) Process Integration, Devices, and Structures; (2) Materials and Bulk Processes; (3) Lithography; (4) Design; (5) Packaging; (6) Factory Automation; (7) Environmental Health & Safety. In addition, the SRC is a partner in the Center for Semiconductor Modeling & Simulation with Los Alamos and Sandia National Laboratories.

The research portfolio at the SRC is the determined by a multi-level review and advisory process. Each of the science areas is managed by a Science Director who is assisted by a Science Technical Advisory Board (STAB) with technical managers from the member companies. Annually, starting from the needs statement in the "Technology Roadmap for Semiconductors", the STAB and the director formulate a strategic and an operations plan that set the portfolio objectives for the coming years. Coordination between the STABs as well as relative funding allocation is managed by the VP or Research Operations and the Executive Technical Advisory Board. Each of the STABs presents both its preliminary as well as its final strategic plan to the ETAB for review. The portfolio for each science area is split into thrust areas. The STABs meet about four times per year to review their programs, typically organized by thrust. These topical reviews bring together at one of the universities the principal investigators and students from various universities, their industrial mentors, the STAB members, and invitees as appropriate.

Modeling & Simulation at the SRC is treated as cross-cut activity, i.e. it exists as a thrust in various science. Each of the science areas has the responsibility to manage the TCAD portfolio in its specific area. Overall coordination between the TCAD efforts in the various science areas has been sporadic and incidental. In addition, the SRC is involved in the "Center for Semiconductor Modeling & Simulation" (CSMS). This is a joint effort with Los Alamos and Sandia National Labs and is run as a separate "pro-forma" science area.

The objective of the CSMS program is to leverage the unique computational physics and chemistry capabilities of the US National Labs. The program consists of 4 thrusts:

- *Grids & Computational Methods:* LaGriT is a library of user callable tools that provide mesh generation, mesh optimization and dynamic mesh maintenance in three dimensions for a variety of applications. Mesh refinement and smoothing are available to modify the mesh to provide more resolution in areas of interest. More information at http://www.t12.lanl.gov/ dcg/ .

- *Bulk Processes:* Low-energy implants for ultra-shallow junctions and low thermal budget annealing to suppress postimplant diffusion have necessitated the development of a new generation of ion implantation simulators. In cooperation between UT Austin and Los Alamos, a new version of UT-Marlowe was developed that incorporates significant advances in predictive accuracy for conventional implants, electronic energy loss, high-energy implants, damage and defect modeling, multiple implants with cumulative damage, ultra-low energy implants, and computational efficiency. A continuum model was developed for boron diffusion based on first-principles calculations and validated by comparison to experiments. Good agreement was demonstrated for a wide range of experimental conditions for low and intermediate boron concentrations.

- *Topography Evolution:* The objective of this thrust is to simulate the deposition and etching of layers of materials on silicon wafers. First-principles calculations were used to develop detailed understanding of the reactive processes. These were implemented in a reaction mechanisms database for use in a 3D topography simulation tool, based on the LaGriT code.

- *Material Reliability:* The objective is to develop a 3D grain-evolution simulator to assess material reliability. This program leverages existing projects at MIT and Dartmouth in 2D grain evolution modeling. Application of LaGriT enabled the development of a 3D grain boundary evolution simulator. The results from this FEM simulator compares favorable with those of a Monte Carlo Potts-model based approach.

In August '98 a workshop will be conducted on "Future Directions in Modeling & Simulation". The goal of this workshop is to identify a set of portfolio objectives for Modeling & Simulation for the SRC. These objectives will then feed into the strategic plans for each of the science areas. In addition, a draft statement of work will be derived for a follow-on of the CSMS CRADA focused on "Modeling & Simulation Beyond the Continuum".

The presentation will provide further detail regarding the SRC, its management processes, portfolio objectives in Modeling & Simulation, and the CSMS, each laced with specific technical examples. Finally, opportunities for international collaboration will be discussed.