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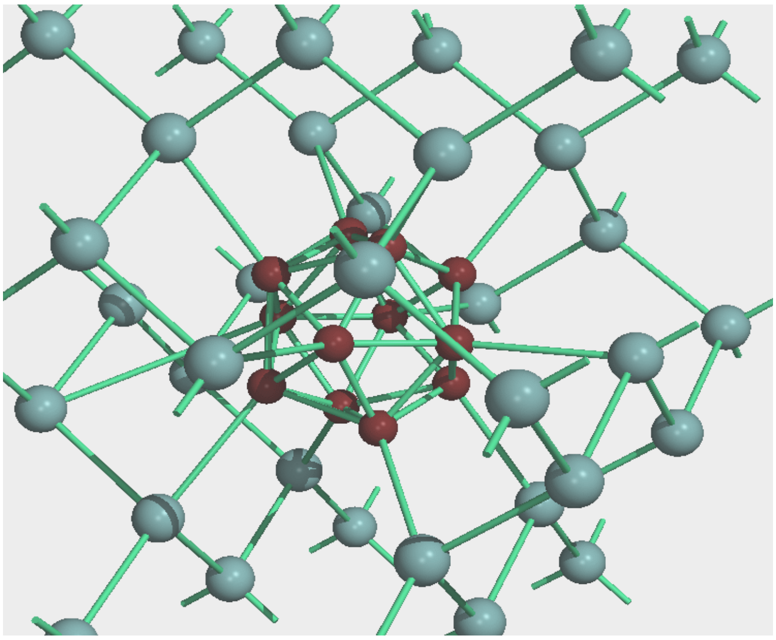
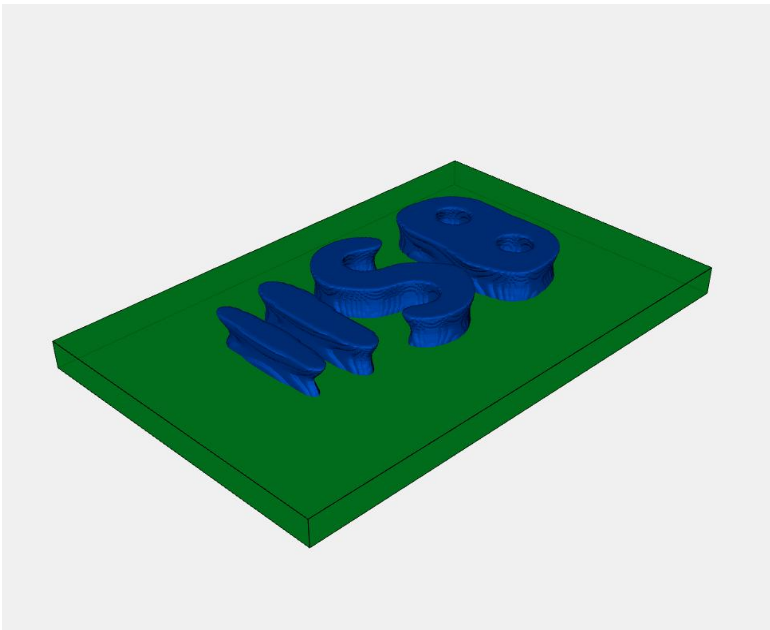
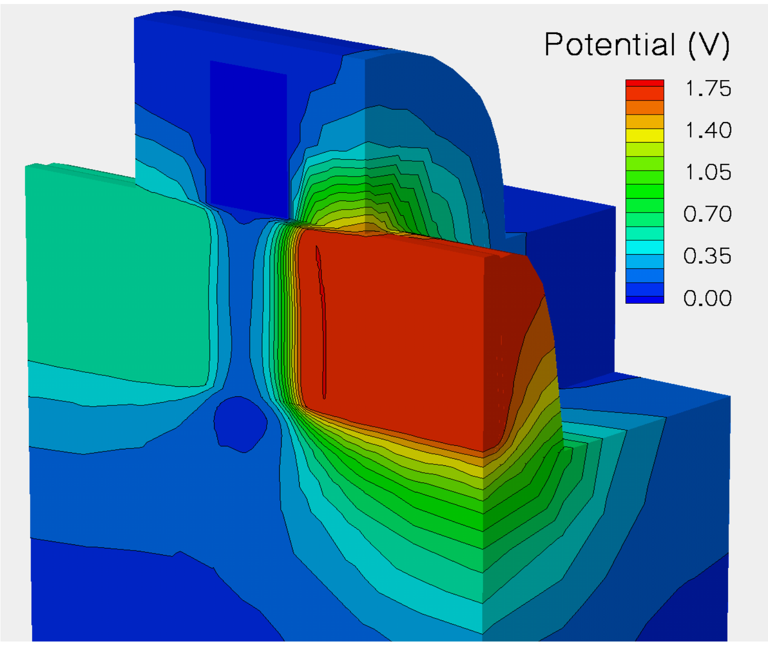
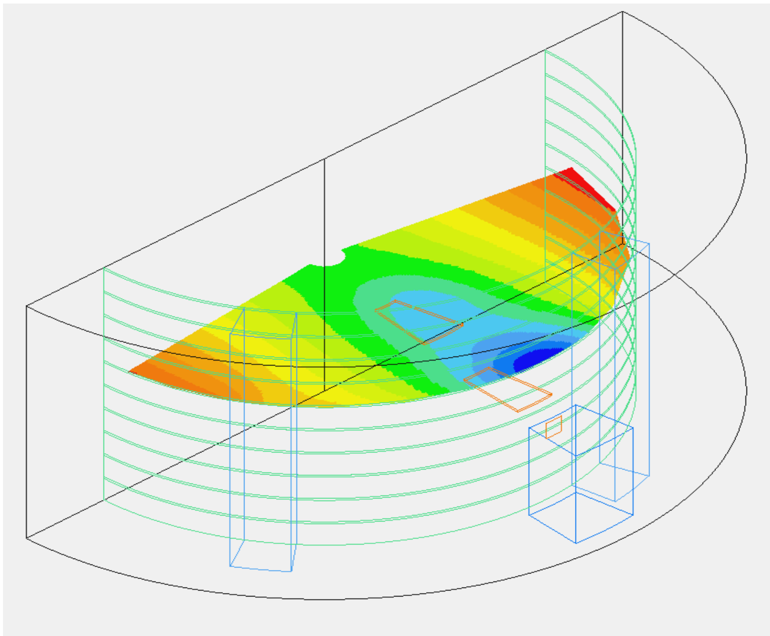
FRAUNHOFER INSTITUTE FOR INTEGRATED SYSTEMS AND DEVICE TECHNOLOGY IISB

TECHNOLOGY SIMULATION







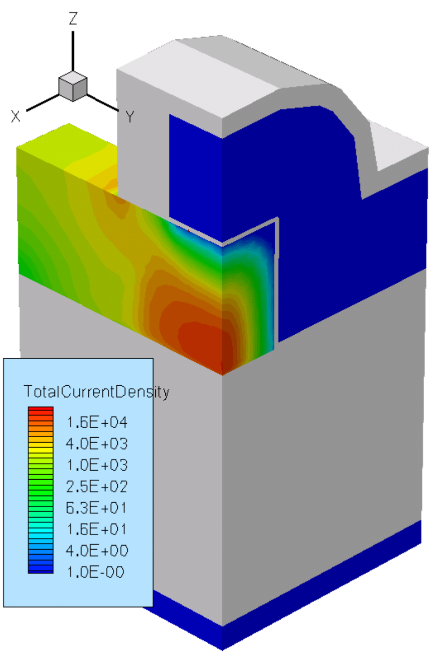


THE TECHNOLOGY SIMULATION DEPARTMENT

What we do

We are developing and applying physical models, algorithms, and simulation programs for semiconductor process steps, manufacturing equipment, semiconductor devices, as well as for integrated systems. The overall goal is to support characterization and optimization of technology, devices, and systems. We closely cooperate with leading semiconductor companies, material and equipment manufacturers, software houses, and research institutions.

Below you will find a description of our various simulation modules and their applications. Please feel free to contact us for further information regarding tailored solutions addressing your specific needs.



Simulated leakage current density in a fin field effect transistor (FinFET)

Doping

We investigate diffusion processes as encountered in semiconductor technology, both theoretically and experimentally. This allows improvement of process characterization and optimization by means of simulation. We develop models and determine the parameters required. Our research topics include electrical activation of dopant atoms, diffusion in multilayer structures, measurements of vacancy concentrations in silicon using platinum diffusion and DLTS, and theoretical work on diffusion mechanisms.

We also work on the development and application of simulation programs that predict dopant concentrations resulting from implantation steps. Furthermore, we simulate electrical properties of devices: We can calculate how modifications of the technological process affect device behavior and how to optimize processes. As we can rely on our comprehensive experience with the application of simulators, we are able to provide extensive support for technology and device optimization.

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Topography

We work on the development and application of simulation programs for topography steps as used in semiconductor technology. This includes physical and chemical modeling on device scale, e.g. of physical and chemical processes at the surface, as well as on equipment scale, e.g. of physical processes and chemical reactions in a plasma-based or thermal reactor. We integrate our software tools with other process simulation programs and with tools for electrical extraction.

Our simulation modules allow simulation of:

- Dry-etching of various materials on substrate level or photomask level
- Conventional and ionized-metal-plasma physical vapor deposition
- Low-pressure chemical vapor deposition
- Superconformal copper deposition
- Chemical-mechanical polishing

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Lithography

We develop physical and chemical models and numerical algorithms for the simulation of lithography processes, covering pre-bake, exposure, post-exposure bake, and resist development. The present activities are focused on optical and EUV projection lithography for semiconductor fabrication. Additional activities cover the modeling of alternative lithographic techniques such as contact or proximity printing, and e-beam lithography.

The developed models are made available through the *Dr.LiTHO* lithography simulation software. *Dr.LiTHO* includes also modules for the optimization and evaluation of lithography processes. Furthermore, we offer comprehensive support regarding process development and feasibility studies.

Current research and development activities include:

- Accurate modeling of light scattering from optical and EUV masks by various electromagnetic field solvers
- Modeling and simulation of various double exposure and double patterning techniques
- Modeling of contact and proximity printing including simulation and experimental characterization of thick resist films
- Modeling of resists for optical, EUV, and e-beam lithography, including model calibration
- Evaluation and optimization of lithography imaging including source mask optimization using genetic algorithms

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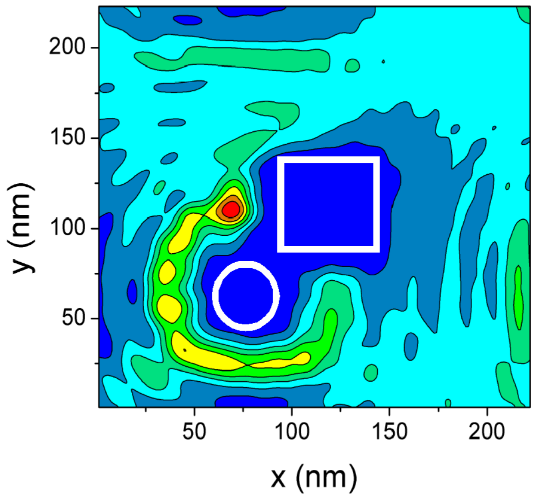

Simulated reflected light of an EUV mask. Blue: lowest intensity, red: highest intensity. The dark area in the center (with rectangle) is induced by the absorber. The lower dark area (white circle) is caused by a mask defect.

Electrical, thermal, and mechanical (ETM) simulation

We apply tools for electrical, thermal, and mechanical simulation to study the stationary and transient behavior of active and passive devices, as well as of systems. This includes transistors on nanometer scale as well as macroscopic modules such as substrates for power electronic applications. In particular, we couple the process simulation modules described above with ETM simulations to investigate the influence of technological parameters on the electrical, thermal, and mechanical characteristics. Applications of our ETM simulations include optimization of performance, reliability, or design for system integration.

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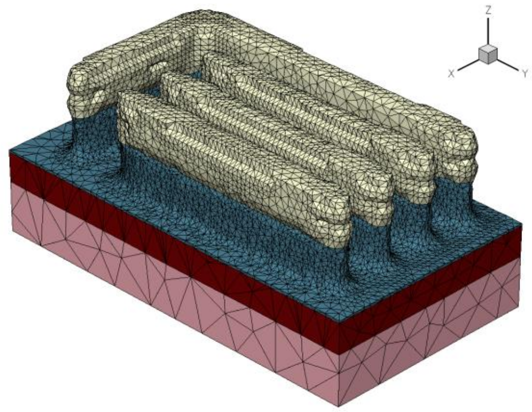
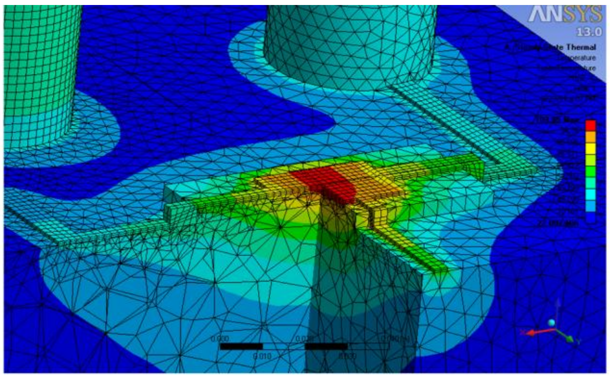


Coupled 3D simulation of lithography and etching



3D simulation of the temperature distribution in a battery module resulting from the heat dissipation due to operation of a semiconductor chip (located in the center of the figure).

Contact

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