

High Performance TCAD: From Simulating Fabrication Processes to Wigner Quantum Transport

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Manufacturing integrated circuits was never a simple process. However, with scaling slowing down more significantly in the single digit nanometer regime due to skyrocketing fabrication costs the need for comparatively cheap simulation-based predictions has further increased. However, the necessary simulation tools in electronics and specifically in semiconductor product development – collectively summarized with the term technology computer-aided design (TCAD) – increasingly struggle with the added complexities. More complicated device geometries (requiring inherently challenging three-dimensional models and simulations), new materials, and arising quantum effects translate to drastically increased computational efforts, in turn resulting in progress-impeding long simulation runtimes. Consequently, reducing simulation runtimes by applying high performance computational methods is vital to prevent impeding the pace of research. Novel modeling and simulation approaches, using parallelization wherever possible, are needed, in turn requiring inter-disciplinary avenues to be explored. In this talk, an overview of the key research areas of the Christian Doppler Laboratory for High Performance TCAD will be given. In particular, key computational challenges and advancements in simulating (1) fabrication processes (e.g. etching [1][2] and oxidation in silicon carbide [3]) and (2) quantum transport in the Wigner picture [4][5][6][7].

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