ViennaSHE: A Semiconductor Device Simulator Based on the Spherical Harmonics Expansion Method

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We first discuss recent developments of the spherical harmonics expansion (SHE) method for semiconductor device simulation. Then, we look into software aspects of making the SHE method accessible to engineers and practitioners.

1. The Spherical Harmonics Expansion Method

The solution of moment-based models for computing approximate solutions of the Boltzmann transport equation is insufficient if the charge carrier distribution function is required. This is for example the case when studying the degradation of semiconductor devices due to so-called hot-carriers [1]. To calculate the charge carrier distribution function numerically, the Monte Carlo method [2] has been the method of choice for decades. However, the excessive execution times entailed by the Monte Carlo method are often prohibitive for practical applications in an engineering environment. Recently, the SHE method has become an attractive alternative, because simulation results can be obtained at only a fraction of the simulation time of the Monte Carlo method, but at comparable accuracy [3]. We present some of the latest research results including adaptive variable-order discretizations, leading to fully three-dimensional simulations of state-of-the-art FinFETs using the SHE method [4].

2. ViennaSHE

Commercial simulators are in regular use by the semiconductor device simulation community. However, novel research results are – by nature – not immediately available in commercial packages, which considerably hampers the reuse of new methods. To address this problem, we make our research work on the SHE method available to the public via the free open source simulator ViennaSHE [5]. In addition to mathematics, physics and engineering aspects, the development of ViennaSHE also requires us to address challenges in scientific computing. We share our experiences from such an inter-disciplinary research and development environment.

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References

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