Introduction

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In this Special Issue on “Advanced Numerical Tools for Transistors based on Silicon and Emerging Materials” we have collected a number of papers resulting from an in-depth analysis and presentation of developments that were announced in a few selected papers from the oral sessions of the 14th IWCE (International Workshop on Computational Electronics) held in October 2010 in Pisa, Italy.

The criterion for the selection of contributions has essentially been the interest they had raised among the reviewers of the IWCE 2010 abstracts and among the workshop participants. They were also chosen to represent a consistent overview of the most exciting current lines of research in the field of Computational Electronics.

The papers of this special issue focus on the numerical simulation of both advanced features of traditional field-effect devices and of challenging issues arising in the investigation of emerging devices, based on new materials or on the addition of novel functionalities.

The first two papers, by Schanowsky et al. and by Garetto et al., address, from different perspectives, the behavior of oxide defects in MOS transistors. Schanowsky et al. discuss the development of a multi-scale model of non-radiative multi-phonon transitions, while Garetto et al. present a comparison of different characterization techniques.

In the third paper, by Vasileska et al., another important aspect of transistor modeling is addressed: thermal effects and, specifically, self-heating, along with proposals on how to improve heat removal. The paper by Dehdashti et al. deals instead with multigate silicon nanowire transistors, which are considered among the most promising device

structures for future nanoelectronics, aiming at an investigation of the consequences of optical phonons on device behavior.

The fifth paper, by Moore et al., presents a numerical tool developed to treat a sensor consisting of an FET transistor whose gate is replaced by an electrolytic solution containing a nanopore, located at a distance of a few nanometers from the oxide: a combination of Brownian dynamics and drift-diffusion approach is used to analyze the behavior of the device and its sensing capabilities.

The following contribution, by Amato et al., focuses on the application of DFT (Density Functional Theory) to devise ways to overcome the reduced ionization of dopants in SiGe core-shell nanowires due to surface effects, quantum confinement effects, and dielectric mismatch.

The final three papers address issues relevant to novel, beyond silicon, materials for emerging devices. The contribution by Ertler et al. investigates the breakdown of ferromagnetic order and the effects of disorder in GaMnAs heterostructures, while the paper by Pennetta et al. focuses on the development of a numerical model for transport and noise in polyacene-based semiconductors; finally, that by Qian et al. presents a modeling approach for the phonon bottleneck effects in rectangular graphene quantum dots.

Such a variety of applications of computational electronics techniques demonstrates the livelihood of this field and the contribution it can give to the final downscaling of CMOS technology, as well as to the rise of novel devices.

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