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A coupled system of partial differential and differential algebraic equations for modeling electrical circuits.

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Abstract

During the talk a coupled model for the simulation of electrical circuits will be presented and some of its properties will be discussed. It couples the differential algebraic equations (DAE) that result when modified nodal analysis is applied to an electrical circuit and the partial differential equations (PDE) modeling the behavior of the semiconductor devices in it. The coupling between the DAEs and the PDEs in the model is given in two ways: on one hand the boundary equations for the PDEs in the system depend on the node potentials of the circuit and on the other hand, the current through the semiconductor devices must enter the Kirchoff's current law equations of the circuit.

In order to numerically simulate electrical circuits modeled by such a coupled system, we dicretize the PDEs in space and solve the resulting DAE with an appropriate numerical method. Two approaches for the discretization of the PDEs in the system will be considered, finite element methods [2, 3] and mixed finite element methods [1], the properties that the discretized equations have in common will be mentioned and the consequences for the resulting DAEs will be discussed. Some numerical simulations will be shown.

References

[1] Brezzi, F., Marini, L. D., Micheletti, S., Pietra, P., Sacco, R., Wang, S., *Finite element and finite volume discretizations of Drift-Diffusion type fluid models for semiconductors*. In: Handbook of Numerical Analysis, W. H. A. Schilders and E.J.W. ter Maten (Editors), North-Holland-Elsevier Science Publishers B.V., 2002.

[2] Mock, M. S., Analysis of Mathematical Models of Semiconductor Devices (Boole Press), 1983.

[3] Markowich, P. A., The stationary semiconductor device equations (Springer), 1986.

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