Stabilized 3D Finite Elements for the Numerical Solution of the Navier-Stokes Equations in Semiconductors

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Abstract

In this article, we deal with the three–dimensional numerical simulation of semiconductor devices using the Viscous–Hydrodynamic (VHD) transport model. A reformulation of the VHD system using entropy variables allows to end up with a quasi-linear form that is symmetric and for which a stability result (in form of Clausius–Duhem inequality) is proved to hold. The numerical approximation of the VHD model is then performed using a Time-Discontinuous Galerkin Least–Squares finite element formulation including a discontinuity shock-capturing operator and based on a fully unstructured tethrahedral decomposition of the device domain. The approach combines in a unified framework the stability and optimality features of the standard Galerkin method with the ability of the scheme in effectively coping with the strong variations attained by the solution throughout the semiconductor device, as is demonstrated by numerical results in the simulation of several benchmark problems subject to quite different boundary conditions.

Key words: Stabilized finite element methods; compressible Navier-Stokes equations; semiconductors; parallelization.

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