Numerical simulation of micro flows with moving obstacles

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Abstract

We present a numerical method for computing unsteady rarefied gas micro flows, in domains with moving boundaries, in view of applications to complex computations of moving structures in micro or vacuum systems. The flow is described by the Bhatnagar-Gross-Krook (BGK) model of the Boltzman equation. A standard approach to simulate incompressible viscous flows with moving boundaries is the immersed boundary method. In this work, we propose an extension of this approach to a deterministic simulation of rarefied flows. The immersed boundary approach consists in keeping the same mesh all along the calculation: every cell of the mesh remains fixed for all time steps while the domain occupied by the gas changes. This strategy avoids to use moving meshes and remeshing approaches, and should be easily applied to problems with complex geometries. The method has been tested with both specular and diffuse boundary conditions and has been validated on several 1D problems (moving piston, actuator, etc.). Up to our knowledge, this is the first time that a deterministic simulation method for rarefied flows with moving obstacles based on the immersed boundary method is presented.