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DSMC investigation of the dynamics of gas surrounding a micro beam/plate undergoing large amplitude oscillations above a substrate

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We present DSMC investigation of the behavior of a gas film in the vicinity of micro-beams and micro-plates undergoing large amplitude oscillatory motion. Applications include micro RF switch and resonators. A two and three-dimensional numerical study of the flow field is performed around a micro-cantilever beam and a micro-plate that oscillates harmonically between an equilibrium position and the fixed substrate underneath. Unlike previous work in literature, the micro structures undergo large displacements throughout the film gap thickness and the behavior of the gas film along with its impact on the moving micro-structure (i.e. force exerted by gas on the micro-structure) are discussed. Since the gas film thickness is of the order of few microns (i.e. $0.01<Kn<1$), the rarefied gas exists in the non-continuum regime and, as such, the Direct Simulation Monte Carlo (DSMC) method is used to simulate the fluid behavior. The impact of the squeeze film on the beam is investigated over a range of frequencies, velocity amplitudes, microstructure dimensions, and for different film gases, corresponding to ranges of dimensionless flow parameters such as the Reynolds (Re), Strouhal (St) and Mach (Ma) numbers. Moreover, the behavior of compressibility pressure waves as a function of these dimensionless groups is discussed for different simulation case studies. We also present an extension of the classical squeeze film damping model that is based on Reynolds lubrication equation, to include nonlinear spring and damping behavior, as well as flow inertia effects.

Biography

Issam Lakkis has completed his Ph.D. in Mechanical Engineering at MIT in 2000. After working for two years in the field of MEMS modeling, he joined the American University of Beirut in 2003, where is current an Associate Professor in the Mechanical Engineering Department. He research interest range from development of grid-free vortex methods for simulating reacting flows to simulation and modeling of micro-flows.

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