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DSMC Simulation of Microstructure Actuation by Knudsen Thermal Force[1] AARON PIKUS, ISRAEL SEBASTIAO, ANDREW STRONGRICH, ALINA ALEXEENKO, Purdue University — Compact, low-power and highly accurate vacuum sensors are needed for emerging applications such as high-altitude communication platforms, small satellites and in-vacuum manufacturing processes. A novel MEMS-based pressure and gas sensor – Microelectromechanical In-plane Knudsen Radiometric Actuator (MIKRA) – has been developed at Purdue. MIKRA is based on Knudsen thermal force generated by rarefied flow driven by thermal gradients within the microstructure. The goal of this work is to model the rarefied gas flow in the MIKRA sensor to validate the numerical modeling of rarefied thermally-driven flows and gain insights for sensor design. The Direct Simulation Monte Carlo (DSMC) solver SPARTA is employed to numerically calculate the distribution of the flowfield and surface properties. The resulting forces on the colder shuttle beam are calculated and compared to the available experimental data as well as other numerical solvers. Both DSMC and experimental results suggest that the maximum forces occur at a Knudsen number of approximately 1. The streamlines indicate the presence of two small vortexes between the heated beam and the colder shuttle beam, and a larger one above these two beams. The DSMC-simulations, validated by experimental measurements, help understand the unique flow behaviors encountered in rarefied thermally-driven flows.

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