Viscous damping of a periodic perforated MEMS microstructure when the Reynolds' equation cannot be applied: Numerical simulations

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Abstract

This paper develops a computational model for determining the total damping coefficient for a unit cell of a MEMS microscale device containing a repetitive pattern of holes. The basic cell of the microstructure is approximated by an axi-symmetric domain and the velocity and pressure fields are determined from solutions of the Navier-Stokes equations using the finite element software package COMSOL. The numerical results for the damping coefficient based on the Navier-Stokes model are compared to the values obtained by using the squeezed film damping given by the Reynold's equation and are found to agree under some restrictive conditions. Finally, the paper provides a comparison of the damping coefficient obtained from the computational model with values given by compact models found in the literature and with measured values for some micro-machined microstructures. Despite its simplicity, the new model yields damping coeficients in closer agreement with the measured values than those of the compact models.