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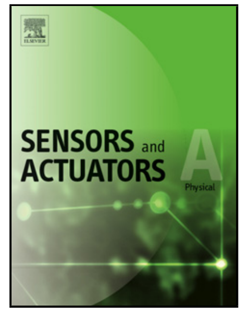

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Influences of temperature on the quality factors of micro-beam resonators in gas rarefaction

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Highlights

1. Quality factors of MEMS resonators are improved significant in gas rarefied flow
2. A new model for coupled effects of temperature and gas rarefaction on SFD is proposed
3. Mean free path with temperature varies more significant than viscosity in low pressures
4. Influence of temperature becomes important in gas rarefaction in microsystems
5. The quality factor increases considerably with temperature in high gas rarefaction

Abstract

In this study, the effect of temperature on the quality factor (Q-factor) of a micro-beam resonator is analyzed in a wide range of gas rarefaction conditions (ambient pressure and accommodation coefficients (ACs)). Squeeze film damping (SFD), thermoelastic damping (TED), and anchor loss, which are dominant damping mechanisms of micro-beam resonators, are included in the total Q-factor. The increase in the mean free path of gas with temperature is more significant than that of the gas viscosity in high gas rarefaction. Thus, the effect of temperature in gas rarefaction is discussed to improve the Q-factors of the resonators. The modified molecular gas lubrication (MMGL) equation is utilized to model SFD. Dynamic viscosity and Poiseuille flow