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Pressure-Dependent Dissipation Effect at Multiple Cantilever Resonant Modes

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Based on the optical deflection method, the resonant characteristics of a microcantilever under various pressure have been observed at room temperature to understand the pressure-dependent dissipation effect. Especially, the quality factor of the cantilever has been measured for up to fourth harmonic mode of cantilever resonance as a function of pressure between 0.1 and 1000 Torr. By considering the intrinsic dissipation present in the system at 0.1 Torr, the pressure-dependent fluidic quality factors were determined for the multiple cantilever resonant modes. The inverse of the fluidic quality factor appears to follow two different asymptotic behaviors at high and low pressure limits, which indicates that the dynamics of the fluid, due to the oscillating cantilever, changes from Newtonian to non-Newtonian with decreasing pressure. The experimentally observed transition of the fluidic dissipation effect agrees well with the recently proposed rapidly oscillating flow model based on the Boltzmann equation, regardless of the different mode shapes.

Keywords: Dissipation, Fluidic Quality Factor, Weissenberg Number, Microcantilever.

RESEARCH ARTICLE