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Quantum Effects on Thermal Vibration of Single-walled Carbon Nanotubes conveying fluid

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Abstract

In this paper, we investigate the microfluid induced vibration of a nanotube in thermal environment. Attention is focused on a special case that the law of energy equipartition is unreliable unless the quantum effect is taken into account. A nonlocal Euler-Bernoulli beam model is used to model the transverse vibration of a single-walled nanotube (SWCNT). Results reveal that the root of mean squared (RMS) amplitude of thermal vibration of the fluid-conveying SWCNT predicted from the quantum theory is lower than that predicted from the law of energy equipartition. The quantum effect on the thermal vibration of the fluid-conveying SWCNT is more significant for the cases of higher-order modes, lower flow velocity, lower temperature, and lower fluid density.

Keywords: Quantum effects, Law of energy equipartition, Fluid-conveying SWCNT, Euler beam theory, Root of mean-squared amplitude

I. Introduction

Carbon nanotubes (CNTs) have been used for gas storage, fluid conveyance and drug delivery because of their superior mechanical, thermal and electrical properties[1,2]. As such, the dynamics of fluid-conveying CNTs have been extensively