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ORIGINAL ARTICLE

A two-temperature model for evaluation of thermoelastic damping in the vibration of a nanoscale resonators

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Abstract In this work, the thermoelastic damping of a nano-scale resonator is analyzed by the generalized thermoelasticity theory based on two-temperature model (2TLS). The effect of two-temperature parameter and relaxation time in nano-scale resonator are investigated for beams under clamped conditions. Analytical expressions for deflection, temperature change, frequency shifts, and thermoelastic damping in the beam have been derived. The theories of coupled termoelasticity and generalized thermoelasticity with one relaxation time can extracted as limited and special cases of the present model. The numerical results have been presented graphically in respect of thermoelastic damping and frequency shift.

Keywords Thermoelastic damping · Two-temperature model · Nano-scale resonator · Vibrations · Frequency shift

1 Introduction

Modeling and simulation of thermoelastic damping is a recurrent interest in the community of nano-engineering and nano-mechanics, mainly motivated by the recent advancement of nanoelectromechanical system (NEMS) technologies. In this size regime, it is possible to attain extremely high fundamental frequencies while simultaneously preserving very high mechanical responsivity (small force constants). Such high-frequency mechanical devices have many important applications among which are ultrasensitive mass detection, mechanical signal processing, scanning probe microscopes, etc. The most important parameter of a nano-resonator is its thermoelastic damping factor, and it is closely related to the accuracy of

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