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The Effect of Relaxation Times on Thermoelastic Damping in a Nanobeam Resonator

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In the present work, in accordance with the generalized theory of thermoelasticity with two thermal relaxation times, the vibration of a thick finite nanobeam resonator has been considered. Both the general thermoelasticity and coupled thermoelasticity (CT) theories with only one relaxation time can be deduced from the present model as special cases. Under clamped conditions for beam, the effect of relaxation times in nanobeam resonator has been investigated. Based on the analytical relationships, the beam deflection, temperature change, frequency shift and thermoelastic damping were investigated and the numerical results were graphically obtained. According to the observed results there is a clear difference between the CT theory, Lord and Shulman's (LS) theory and Green and Lindsay's (GL) theory.

Keywords: Frequency shift; free vibrations; nanobeam resonator; thermoelastic damping; green and lindsay theory.

1. Introduction

Nanoelectromechanical systems (NEMS) always reach large operation frequencies due to their decreased size as well as small force constants. Some important applications of the high-frequency mechanical devices include the processing of mechanical signal, ultrasensitive mass detection, scanning probe microscopes, etc. In the community of nanomechanics and nanoengineering, the modeling and simulation of thermoelastic damping is a recurrent interest, mainly motivated by the recent advancement of NEMS technologies. Modeling and simulation of thermoelastic damping is a frequent interest in the nanomechanics and nanoengineering communication, basically included by the recent progress in NEMS technology.

During the last three decades, great efforts have been done to generalize thermoelasticity theories