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Vibration of circular micro-ceramic (Si_3N_4) plate resonators in the context of the generalized viscothermoelastic dual-phase-lagging theory

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Abstract
In this article, the analysis and numerical results are represented for the thermoelastic of an isotropic homogeneous, thermally conducting, Kelvin–Voigt-type circular micro-plate in the context of Kirchhoff's Love plate theory of generalized viscothermoelasticity based on the dual-phase-lagging model. The governing equations are obtained for the generalized dual-phase-lagging model and coupled viscothermoelastic plates. The scaled viscothermoelasticity has been illustrated in the case of the circular plate and the axisymmetric circular plate for an aspect ratio for clamped boundary conditions. Laplace transform has been applied, and its inversions have been calculated numerically by using the Tzou method. The results have been carried out for the ceramic (Si_3N_4). It is noted that the temperature increment and lateral deflection are significantly affected by the time, the width, the thickness, and the mechanical relaxation times of the material.

Keywords
Viscothermoelasticity, dual-phase-lag, relaxation times, circular micro-ceramic

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Introduction

Heat conduction has been studied using mathematical models such as dual-phase lag (DPL), which was proposed by Tzou.[1,2] The temperature gradient and heat flux were established by this model. Many scientists used this model in heat transfer problems,[3] physical systems,[4–8] and thermoelastic damping vibration.[9,10] Guo et al.[11,12] used the DPL model to analyze the thermoelastic damping theory of micro- and nanomechanical resonators; then, he investigated the dissipation in the circular micro-plate resonator.

The circular plate is a common structural in many micro-and nano-electromechanical resonators. Hao[13] adopted an analytical study to analyze thermoelastic damping in vibrations of micro- and nano-electromechanical circular thin-plate resonators. Sun and Tohmyoh[14] studied thermoelastic damping on axisymmetric out-of-plane vibration of circular plate resonators. Sun and Saka[15] investigated the thermoelastic damping effects on the out-of-plane vibration of circular plate resonators. They added a factor in their formula of thermoelastic damping $K = (1 + \upsilon)/(1 - 2\upsilon)$, which is different from that of Lifshitz and Roukes,[16] in which υ is Poisson's ratio. Li et al.[17] employed an analytical study to analyze thermoelastic damping in

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