Study of the temperature effect in fractional thermoelasticity at micro- nano scale

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Traditional continuum models are insufficient for accurately depicting thermoelastic behavior at micro- and nano-scales, where size-dependent effects become significant. Long-range interactions at these scales strongly influence the thermomechanical response of structural systems. A novel method for simulating such nonlocal phenomena is space-fractional continuum mechanics, which uses fractional calculus. Space-fractional models can effectively represent size-dependent mechanical responses, but their application to thermoelastic problems remains constrained. A space-fractional thermoelastic framework for analyzing beam structures at the micro- and nano-scales has been described in this work. By accounting for temperature-dependent material characteristics, thermal effects are incorporated, enabling the examination of the impact of temperature changes on structural response within a coherent continuum framework. The impacts of Young's modulus, material grain size, and fractional order under various temperature conditions and boundary conditions are assessed through a parametric study. Overall, the suggested model advances our understanding of thermomechanical behavior at small scales and provides a useful framework for the study and design of micro- and nanoscale systems, such as MEMS and NEMS devices, where thermal effects are crucial.

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