Thermal Vibration of a Rectangular Single-layered Graphene Sheet with Initial Stress Embedded in Elastic Medium

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Abstract

The thermal vibration of a rectangular single-layered graphene sheet with initial stress embedded in an elastic medium is studied by using the Kirchhoff plate model of continuum mechanics with quantum effects taken into consideration when the law of energy equipartition is unreliable. The basic finding of this paper is the relation, derived by the Kirchhoff plate model considering quantum effects, between the temperature and the Root-of-Mean-Squared (RMS) amplitude of thermal vibration at any point of the rectangular single-layered graphene sheet with initial stress which is embedded in the elastic medium. The RMS amplitude of the rectangular single-layered graphene sheet in the elastic medium predicted by quantum theory is lower than that predicted by the law of energy equipartition. The quantum effect is more significant for thermal vibration under higher-order modes, smaller size and lower temperature case. The absolute difference of maximal RMS amplitude of thermal vibration of the rectangular single-layered graphene sheet with initial stress embedded in an elastic medium predicted by the Kirchhoff plate model with the law of energy equipartition and that with quantum effects increases slowly with the rising of Winkler modulus. The effect of initial stress on the thermal vibration of graphene is also discussed.

Keywords: RMS Amplitude, Law of Energy Equipartition, Graphene, Quantum Effects, Initial Stress