Steady State Thermal Non-linear Stability Analysis of Bi-directional Nanotube based Functional Graded Composite Plate

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Abstract

The study of steady state thermal non-linear stability in bi-directional nanotube-based functionally graded composite plates (FGCPs) is crucial for modern engineering applications involving advanced materials. This research investigates the thermal stability behavior of FGCPs reinforced with bi-directionally aligned carbon nanotubes (CNTs), focusing on their response to steady state thermal loads. The composite plates are modeled with spatially varying material properties, engineered through functionally graded distributions of CNTs to achieve optimal thermal and mechanical performance. A non-linear thermal stability analysis is conducted using a combination of higher-order shear deformation theory and von Kármán-type geometric nonlinearity. The governing equations are derived through the Hamilton's variational principle and solved numerically to capture the non-linear thermal deflection and post-buckling behavior under various boundary conditions. Results highlight the influence of bi-directional CNT reinforcement, grading profiles, and temperature distributions on the thermal stability and structural resilience of the composite plates. The study provides insights into optimizing the design of nanotube-reinforced FGCPs for applications requiring high thermal stability and mechanical robustness, such as aerospace and high-performance structural components.

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