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Poisson's ratio effects on the mechanics of auxetic nanobeams

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Abstract

Poisson's ratio is an important mechanical property that explains the deformation patterns of materials. A positive Poisson's ratio is a feature of the majority of materials. Some materials, however, display "auxetic" behaviors (*i.e.* possess negative Poisson's ratios). Indeed, auxetic and non-auxetic materials display different deformation mechanisms. Explaining these differences and their effects on the mechanics of these materials is of a significant importance.

In this study, effects of Poisson's ratio on the mechanics of auxetic and non-auxetic nanobeams are revealed. A parametric study is provided on effects of Poisson's ratio on the static bending and free vibration behaviors of auxetic nanobeams. The general nonlocal theory is employed to model the nonlocal effects. Unlike Eringen's nonlocal theory, the general nonlocal theory uses different attenuation functions for the longitudinal and lateral strains. This theory emphasizes the Poisson's ratio-nonlocal coupling effects on the mechanics of nanomaterials. The obtained results showed that Poisson's ratio is an essential parameter for determining mechanical behaviors of nanobeams. It is demonstrated that auxetic and non-auxetic nanobeams may reflect softening or hardening behaviors depending on the ratio of the nonlocal fields of the beam's longitudinal and lateral strains.

Keywords: auxetic; nanobeam; negative Poisson's ratio; nonlocal; mechanics.

1. Introduction

Poisson's ratio is a vital measure for elastic-deformation of materials. Poisson's ratio, ν, is explained as the ratio of the lateral contraction in a solid material to its longitudinal extension due to an axial tension (Lakes, 1993). The significant importance of Poisson's ratio is that it provides a vision on the structural behavior of materials. For instance, Poisson's ratio can be considered as a measure of the compressibility

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