Equilibrium and stability of anisotropic hyperelastic graphene membranes. (English)

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Summary: The lack of experimental investigations on graphene fostered researchers to focus on its mechanical modeling. Being graphene a one-atom-thick sheet, many authors developed continuum membrane models to analyze its mechanical behavior. However, an entirely nonlinear approach in finite elasticity has not been presented so far. In this work, the equilibrium problem of anisotropic hyperelastic graphene membranes is addressed. Strain and stress measures are expressed under the hypothesis of homogeneous deformations and the boundary-value problem is formulated for a graphene membrane subjected to biaxial loads. The stability of the equilibrium configurations is assessed through an energy criterion. Explicit relations between stretches and stresses of the membrane are derived for the cases of uniaxial and equibiaxial loads. Unexpectedly, bifurcation and multiple equilibrium solutions are found when graphene is subjected to equibiaxial loads. A linearization of the finite theory is presented and the expressions of Young’s modulus and Poisson’s ratio of graphene are derived. The formulation proposed in this work may be the basis for accurate investigations of the mechanics of graphene subjected to large deformations.

MSC:
74K15 Membranes
74G60 Bifurcation and buckling
74B20 Nonlinear elasticity
74E10 Anisotropy in solid mechanics

Keywords: finite elasticity; linearization; homogeneous deformation; stress measure; boundary value problem; biaxial load; bifurcation

Software:
Optimization Toolbox; Matlab; Mathematica

Full Text: DOI

References:


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