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Analysis of nano-plates by atomistic-refined models accounting for surface free energy effect.

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Summary: This work presents several higher-order atomistic-refined models for the static and free vibration analysis of nano-plates. Stemming from a two-dimensional approach and thanks to a compact notation for the a priori kinematic field approximation over the plate through-the-thickness direction, a general model derivation is used where the approximation order is a free parameter of the formulation. Several higher-order plate theories can be obtained straightforwardly. Classical plate models, such as Kirchhoff's and Reissner's, are obtained as particular cases. The assumed constitutive equations for orthotropic materials are those derived by *R. Dingreville* et al. [J. Mech. Phys. Solids 53, No. 8, 1827–1854 (2005; Zbl 1120.74683)], which account for the surface free energy effect as well as the third-order elastic constants. The resulting stiffness coefficients depend upon the thickness. The governing equations and boundary conditions are variationally obtained through the principle of virtual displacements. A Navier-type, strong form solution is adopted. Simply supported plates are, therefore, investigated. Static and free vibration analyses are carried out in order to investigate the effect of the thickness side as well as the crystallographic plane orientation on the mechanical response. Plates with different values of the side-to-thickness ratio are considered. Results are validated in terms of accuracy and computational costs toward three-dimensional FEM solutions. Numerical investigations show the advantages of refined plate models over the classical ones demonstrating that accurate results can be obtained with reduced computational costs.

MSC:

74K20 Plates
74A60 Micromechanical theories
82D80 Statistical mechanics of nanostructures and nanoparticles

Software:

FADBAD++; ANSYS

Full Text: DOI

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