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Hyperelastic modeling for anisotropic crystal structures using strain invariants

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In this work, we have developed a new hyperelastic model for anisotropic crystal structures using strain invariants. A simple polynomial based strain energy density function is proposed for the hyperelastic model. Strain invariants for crystal structures are directly used as polynomial bases of the function. The material constants of the function is determined by using least square method, and interatomic potentials and ab initio simulations are utilized to calculate the reference values of the fitting method. As test materials, we use copper for face-centered cubic (FCC) system, silicon for diamond structure, and graphene for hexagonal 2-D system. In the presentation, some numerical examples using nonlinear finite element method will be provided to validate the usability of the proposed hyperelastic model.

Keywords: Hyperelastic model, Cauchy-Born rule, anisotropic, crystal structure, nonlinear finite element method