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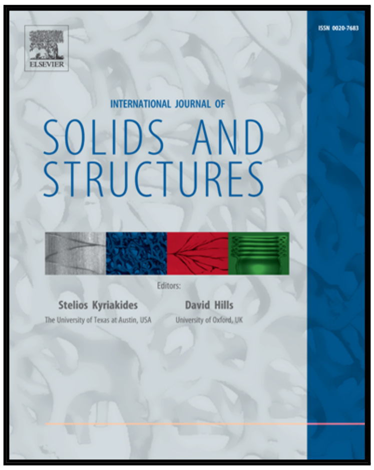

Interface behavior of physical hydrogel subject to solution-gel phase transition and nonlinear deformation

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Interface behavior of physical hydrogel subject to solution-gel phase transition and nonlinear deformation

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ABSTRACT

In this paper, a multiphysics model is developed for simulation of the interface behavior of physical hydrogel subject to solution-gel phase transition and nonlinear deformation, in which the solution and gel states are considered as two distinct phases and separated by a sharp interface approach. The presently developed model accounts for the multiphysics effects of the mechanical, chemical and thermal coupled fields. Apart from the classical governing equations for mass and energy conservations, and for the force equilibrium in the two bulk phases and on their interface, an additional equilibrium equation for a so-called configurational force is imposed in the two bulk phases and on their interface for the effect of the solution-gel phase transition. The corresponding configurational heating and mass supply are also proposed to account for energy change due to the migration of the control volume. By the second law of thermodynamics, the constitutive equations are formulated, including an evolution equation for the interface. The present model will reduce to Suo's non-equilibrium thermodynamic theory, if the interface is ignored when only a single bulk phase exists, i.e. no phase transition occurs. In order to model the phase behavior of physical hydrogel, which directly results from breaking and forming of crosslinks, a novel formulation of the free energy is proposed, which accounts for the effect of crosslink density to characterize the phases, and may reduce to that for a chemical hydrogel

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