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An enhanced finite element formulation for the coupled diffusion in gels at a swollen reference configuration

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ABSTRACT

This presentation is concerned with the development of a large-deformation, continuum-level theory to describe the coupling of the interaction of mechanics and chemistry for polymeric networks, capable of absorbing fluid-like chemical species. The mixture of solid and solvent is treated as a homogenized continuum. To overcome numerical challenges, a new approach for the approximation of the different field variables is presented in the context of the enhanced finite element method at finite deformations. A thermodynamically consistent theory, which is in full agreement with the supposedly incompressible behavior of both the solid and the solvent phase of the mixture, is developed. The change in entropy due to mixing the fluid and the polymer network is based on the Flory–Huggins model and the change in the configurational entropy due to stretching the network is based on a model for Gaussian chains. A statistical mechanics approach for a preswollen reference configuration is presented.