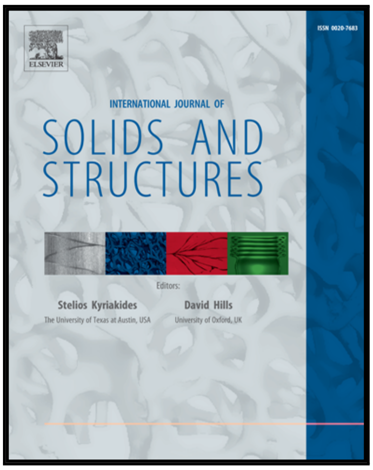

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PII:	S0020-7683(17)30245-7
DOI:	10.1016/j.ijsolstr.2017.05.034
Reference:	SAS 9596

To appear in:	*International Journal of Solids and Structures*

Received date:	24 November 2016
Revised date:	22 May 2017
Accepted date:	24 May 2017

Please cite this article as: Lukas Böger, Aref Nateghi, Christian Miehe, A Minimization Principle for Deformation-Diffusion Processes in Polymeric Hydrogels: Constitutive Modeling and FE Implementation, *International Journal of Solids and Structures* (2017), doi: 10.1016/j.ijsolstr.2017.05.034

A Minimization Principle for Deformation-Diffusion Processes in Polymeric Hydrogels: Constitutive Modeling and FE Implementation

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Abstract

This paper presents a recently developed, innovative minimization principle for coupled deformation-diffusion processes applied to hydrogels and compares this new structure with the classical saddle point formulation in both variational foundation and finite element implementation. First, balance equations and boundary conditions associated with dissipative fluid transport in solids undergoing large deformation are shown to be rooted in a canonical minimization formulation. This two-field principle determines the deformation rate and the fluid flux, constitutively governed by the scalar free energy and the dissipation potential functions. It can be used to derive the well-known saddle point formulation by a Legendre transformation of the dissipation potential. Next, the variational potential is transformed to its incremental counterpart by means of a discretization in time, which offers an intuitive and unconstrained discretization within the finite element method. To this end, vectorial Raviart-Thomas shape functions are chosen for flux degrees of freedom in order to fulfill the required $H(\mathrm{Div}, \mathcal{B})$ conformity. The need for this ansatz space can be interpreted as a counterpart to the LBB condition that arises within the saddle point principle and is usually addressed by mixed element formulations. However, we are able to demonstrate equivalent or superior performance of the minimization princi-

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Preprint submitted to Elsevier *June 2, 2017*