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VARIATIONAL FORMULATIONS FOR LARGE STRAIN THERMO-ELASTODYNAMICS BASED ON THE GENERIC FORMALISM

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GENERIC (General Equation for the Non-Equilibrium Reversible-Irreversible Coupling) is a double-generator formalism for the thermodynamically consistent formulation of problems from continuum mechanics. The GENERIC-based formulation relies on an additive decomposition of the evolution equations into a reversible part and a dissipative part. While the reversible part is generated by the total energy of the system, the irreversible part is generated by the total entropy. Originally, GENERIC has been developed in the context of complex fluids. We refer to the book by Öttinger [1] for a comprehensive account of the GENERIC formalism up to the year 2005.

More recently, the GENERIC framework has been extended to solid mechanics (see [2, 3, 4]. Romero [5, 6] recognized at an early stage the great potential of the GENERIC framework for the design of structure-preserving numerical schemes and coined the notion of a thermodynamically consistent (TC) method. Alternatively, TC schemes may be termed Energy-Momentum-Entropy (EME) schemes. These methods can be viewed as extension to dissipative systems of earlier developed Energy-Momentum (EM) schemes for conservative systems with symmetry such as large strain elastodynamics and flexible multibody dynamics (see [7] for a comprehensive overview of previous developments in this direction).

Previously developed GENERIC-based TC methods for thermomechanically coupled solids are typically subject to serious limitations such as (i) the use of the entropy density as thermodynamical variable, and (ii) the restriction to isolated (or closed) systems in which the boundaries are neglected. In the present talk we propose a generalized GENERIC-based formulation that (i) allows for the free choice of the thermodynamical variable among either the temperature, internal energy density or entropy density, and (ii) takes into account the boundaries of the system. The new formulation lays the ground for the design of structure-preserving (e.g. TC) methods for the solution of initial boundary value problems for thermomechanically coupled solids. In the talk we focus on the dynamics of thermoelastic solids with heat conduction.

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