20th European Mechanics of Materials Conference - EMMC20
Florence, Italy | May 27th-29th, 2026
www.emmc20.unifi.it

The role of Onsager and other variational principles in the formulations of flow rules for growth and remodeling

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Paper ID: 255
Symposium S7: Mechanics of soft materials and structures

Abstract

Soft materials and structures, including biological tissues and active materials, exhibit complex inelastic behaviors such as growth and remodeling [1]. Capturing these phenomena within a continuum mechanics framework poses significant challenges, as they involve the coupled evolution of mechanical fields and inelastic variables. The governing equations are typically nonlinear and require a careful formulation to ensure thermodynamic consistency. In this context, variational principles may help in deriving evolution laws and developing robust numerical treatments. In this work, we contrast Onsager's and other variational principles in deriving flow rules for growth and remodeling in soft matter. This approach, widely employed in hydrodynamics, polymer science [2], and mechanics [3], is based on representing evolution equations for suitably chosen state variables. We review and critically examine the resulting flow rules through the analysis of simple representative processes occurring in soft materials and structures, also comparing the choice of a material or spatial description for the inelastic state variables [4].

Keywords:

remodeling mechanics inelasticity intrinsic metric flow rules

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