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A VARIATIONAL-BASED MIXED FINITE ELEMENT FORMULATION FOR LIQUID CRYSTAL ELASTOMERS

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Liquid crystal elastomers (LCEs) are soft materials, which are capable of large deformations induced by temperature changes and ultraviolet irradiation [1]. Since many years, these materials are under investigation in experimental researches as actuator materials. LCEs arise from a nematic polymer melt, consisting of long and flexible polymer chains as well as oriented and rigid rod-like molecules, the so-called mesogens, by crosslinking.
In order to numerically simulate LCE materials by using the finite element method, a continuum model is necessary, including in a thermo-viscoelastic material formulation of the polymer chains the orientation effects of the mesogens. This can be performed by introducing a normalized direction vector as an independent field, and deriving from additional (orientational) balance laws independent differential equations [2]. These differential equations describe the independent rotation of the rigid mesogens connected with the flexible polymer chains. The orientation-dependent stress law of LCEs arises from an anisotropic free energy, comparable with fibre-reinforced materials. But, in contrast to fibre-reinforced materials, the direction vector of a LCE model has to be independent.
In contrast to [2], we apply a variational principle for deriving a new mixed finite element formulation, which is based on drilling degrees of freedom for describing the mesogens rotation [3]. This principle leads to an extended set of balance laws.

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