Polyconvexity in the context of Large Strain Electromechanics

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ABSTRACT

In this paper, a new computational framework is presented for the analysis of large strain electromechanics. The framework is not restricted to either energy harvesters or smart actuators, but it is applicable to the wide spectrum of piezoelectric polymers.

Polyconvexity **[3]** is these days a well known mathematical requirement employed to characterise admissible strain energy functionals in the large strain regime **[1,2].** The objective of this work is the extension of this condition to the field of electromechanics, where a new energy functional is introduced as a polyconvex combination of both strain and electric variables **[4]**. This consideration leads to well posed energy functionals which satisfy ellipticity and thus, the correct wave speed propagation. Moreover, spurious numerical instabilities can then effectively be removed from the model whilst maintaining real physical instabilities.

A variety of energy functionals are defined exploiting the properties of the piezoelectric polymer under investigation. Material characterisation is carried out by means of experimental matching in the linearised regime (i.e. small strains and small electric field).

The resulting variational formulation is discretised in space using the Finite Element Method, where the resulting system of nonlinear algebraic equations is solved via the Newton-Raphson method after consistent linearisation. Finally, a series of numerical examples are presented in order to assess the capabilities of the new formulation.

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