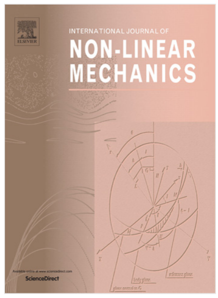

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Numerical modelling of thermo-electro-viscoelasticity with field-dependent material parameters

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Abstract

In this contribution, we propose a mathematical framework and its numerical implementation for thermo-electro-viscoelasticity taking into account field-dependence of the relevant material parameters appearing in the constitutive model. Polymeric materials are typically viscoelastic and highly susceptible to thermal fluctuations. Several experimental studies suggest that major material parameters appearing in a constitutive model of a thermo-electro-mechanically coupled problem evolve with respect to temperature as well as the applied electric field. Hence we propose a framework for the realistic modelling of polymeric materials under coupled thermo-electro-mechanical loads in which the temperature and electric field are not only considered as independent fields but also show an effect on the material parameters. Furthermore we present the numerical discretization of the coupled balance laws within the context of the finite element method. To demonstrate the performance of the proposed thermo-electro-mechanically coupled framework, several boundary value problems are solved numerically.

1. Introduction

Among the class of smart materials, electro-active polymers (EAPs) drew special attention in the past decade thanks to their large actuation mechanisms and relative low production cost. Upon the application of an external electric field, EAPs can undergo both changes in size and shape as well as in their mechanical attributes, such as stiffness or viscosity. Potential applications of EAPs have already been provided in a large variety of engineering fields, e.g. artificial muscles in soft robotic mechanisms, optical membranes for shape correction in lenses, or energy harvesting [32, 51], to mention a few. Due to the interplay of the mechanical and the electric field the system of governing equations needs

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