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A THERMO-ELECTRO-VISCOELASTIC MATERIAL MODEL FOR THE SIMULATION OF VHB 4905

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In the past decades the design of state-of-the-art technology lead to an increased interest in so-called smart materials, a promising representative of which are electro-active polymers (EAPs). These materails react with large deformations and a change in their material properties to an external excitation by an electric field which makes them interesting candidates for commercial applications such as adaptive stiffness actuators, soft generators or adaptive lenses in optics. As polymeric materials are especially sensitive towards thermal influences, the changes in temperature due to external and internal effects should not be neglected. Due to the expensive and time consuming nature of real-life experimental work there is a high demand for the simulation of these innovative materials using numerical solution approaches such as the finite-element method. In this contribution we present a thermo-electro-viscoelastic material model with field dependent material parameters based on the work of Hossain et al. [1] that can be used for the simulation of electro-active polymers. We select an eight-chain model for the ground state elasticity whereas the viscous material behavior is represented by a Neo-Hookean type model using the linear evolution equation proposed by Lubliner [2]. We assume that in general all the material parameters used for the formulation of the energy function of our modelling approach may depend both on the electric field and the temperature. The derived material model is implemented into an in house finite-element code using the FE library `deal.II` [3]. We simulate a number of standard experiments such as single-step relaxation tests and loading-unloading cyclic tests in order to characterize the behavior of the commercially available dielectric polymer VHB 4905 from 3M. The results of the finite element simulations are compared to real-life electro-mechanical experimental data.

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