A complete direct approach to electrostrictive polymer plates and shells

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ABSTRACT

In this paper we discuss modeling of electrostrictive polymer plates and shells as electro-elastic material surfaces. A complete direct approach is developed without the need to involve the three-dimensional formulation. Ponderomotive forces as well as constitutive coupling by means of electrostriction are accounted for. We propose a rational formulation for the augmented free energy of electro-elastic material surfaces incorporating electrostriction by a multiplicative decomposition of the surface stretch tensor and an additive decomposition of the surface curvature tensor into elastic and electrical parts. Moreover, we show that concepts such as the total stress, the electrostatic stress and the mechanical stress exist also for electro-elastic material surfaces. Results computed within the framework of this complete direct approach are compared to results within the corresponding three-dimensional formulation; in both approaches, numerical solutions are computed with electromechanically coupled Finite Elements.