Electrostrictive multilayer polymer actuator dimensioning and modelling for continuum snake like robot application

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ABSTRACT

Electro-active polymers have been studied in the last few years as active materials while submitting to an electric field for self-bending or self-folding smart structure [*]. Those materials could improve micro-scale robot devices for their compact design, high strain and law cost. Electrostrictive polymers as they need a high actuation voltage are studied as multilayers sheets mixed with electrodes and a passive substrate in order to increase the global strain. In this work, the poly(VDF-*ter*-TrFE-*ter*-CTFE), a relaxor ferroelectric terpolymer is studied for his large electromechanical strain. A wide range of parameters involved in the active material such as the number of layers, terpolymer composition, substrate materials has led us to the development of a finite element model on Abaqus to guide the experimental development [1]. To control this actuator, its physical behavior has been modeled. The geometric model is based on the Denavit-Hartenberg method and the Frenet-Serret method [2] following a snake like continuum robots equivalence. For the dynamic model an analogy with thermal propagation in a multilayer cantilever beam has been studied [3]. The nonlinear behavior of the electrostrictive induced strain depending on the voltage had to be experimentally defined. The global stress is based on the integration of the strain in every layer and the bending comes from the strain variation between the passive substrate and the active material [4] [5].

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