CHARACTERIZATION AND CONSTITUTIVE MODELING OF ELECTROACTIVE POLYMERS

A. M. Vinogradov

Department of Mechanical Engineering
Montana State University
Bozeman, Montana, 59717, USA
vinograd@me.montana.edu

Electroactive polymers are characterized by their ability to actively react to changing stimuli as a result of energy conversion from mechanical to electrical and vice versa. This property is often compared with biological reactions involving transformations of the sensed information into the desired response. Due to such special qualities, electroactive polymers have been increasingly used in a broad, rapidly expanding range of applications. A special class of electroactive polymers of immediate practical significance derives its electromechanical response from piezoelectricity observed in the form of an electric charge or voltage produced by applied mechanical forces or, conversely, in the form of mechanical deformations induced by an applied electric field.

Typically, the electromechanical properties of piezoelectric polymers are described within the framework of linear piezoelectricity. This approach, however, tends to ignore the dielectric and mechanical energy losses, time-dependent and nonlinear effects [1].

This paper provides a critical discussion of the current approaches to material characterization and constitutive modeling of electroactive polymers. The paper consists of two parts. The first part contains a summary review of the experimental findings, demonstrating that electroactive polymers exhibit time-dependent nonlinear behavior in terms of piezoelectric, dielectric, and mechanical relaxation, and nonlinear effects under cyclic loading conditions [2-4]. The second part of the paper presents a nonlinear viscoeleastic constitutive theory that takes into account stress induced material nonlinearity, temperature effects and damage evolution in polymers. The predictive capability of the developed theory has been validated experimentally.

References

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