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# Multiscale analysis of the coupling between mechanics and electrostatics in polymer chain networks

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## ABSTRACT

Electroactive polymers (EAPs) are materials capable of undergoing large deformations when stimulated by an electric field. At the present, there are models describing the polymers uncoupled electrostatic response under the influence of an electric field at both the macroscopic and the microscopic levels. Similarly, there are models describing the polymers reaction to purely mechanical loadings, macroscopically as well as through their molecular microstructure. The connection between the micro- and the macroanalyses shed light on the overall response of polymers and provide tools for optimizing their performances. In recent years, the electro-mechanical coupling in EAPs has been characterized and modeled at the macroscopic-continuum level. To the best of our knowledge, the corresponding analysis at the molecular microscopic level is not available yet.

Our studies [1–2] is aimed towards understanding and analyzing the relation between the structure of EAPs and the forces and stresses that develop due to electrostatic excitations. To this end we introduce a multiscale model that assumes known geometries of the chains before and after the deformation. In addition, a variational approach is used leading to the development of an expression for the internally stored electrical enthalpy in the polymer and the corresponding stresses that develop. In a way of an example a polymer with specific chain structure under constant electric excitation and axial deformation is examined. The results are compared with a common phenomenological model as well as with experimental findings.

## REFERENCES

[1] Cohen, N., deBotton, G. The electromechanical response of polymer networks with long-chain molecules. *Math. Mech. Solids*. 2014 (to appear).

[2] Cohen, N., deBotton, G. Multiscale analysis of the electromechanical response of dielectric elastomers. *Eur. J. Mech. A-Solids*, 2014.