20th European Mechanics of Materials Conference - EMMC20
Florence, Italy | May 27th-29th, 2026
www.emmc20.unifi.it

The response of a medium with interacting dipoles to external electrical excitation

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Paper ID: 441
Symposium S7: Mechanics of soft materials and structures

Abstract

We study the overall response of a dipolar medium with a large number of infinitesimal dipoles to external electrical excitation. This is accomplished within the framework of statistical mechanics theory. When the medium is subjected to an external electric field, the competition between the tendency of the dipoles to orient with the field and the system tendency to maximize the entropy dictates the overall orientational distribution. However, as the overall orientation of the dipoles deviates from the excitation-free random distribution, the collective field of the polarized dipoles themselves becomes substantial and must be accounted for. To account for this dipole-to-dipole interaction, we express the average polarization of the medium in terms of the sum of the external and the internal fields. This leads to an implicit self-consistent equation from which the overall response of the medium can be determined. In this presentation, we highlight the construction of this equation and discuss a few preliminary results for different types of dipoles. We show the richness of the responses of the medium to different levels of electric field and demonstrate that in limiting cases, our results agree with corresponding widely used analytical and experimental findings.

Keywords:

Dipolar Medium Dipole-to-dipole interaction Dielectric Elastomers Statistical Mechanics Self-Consistent method