Effective Properties of Viscoelastic Composite with Piezoelectric Fibers

M. Al-Ajmi[1], P. Muthusamy[1]

[1]Mechanical Engineering Department, Kuwait University, Kuwait

Abstract

Numerical homogenization of fiber reinforced composites has become a valuable design tool by utilizing the power of modern Finite Element Analysis. Piezoelectric materials are used extensively as sensors and actuators. Piezoelectric composites are more desirable than the homogeneous layers since they relatively overcome the brittleness disadvantage of piezoelectric material and can be tailored for a better performance in specific applications.

In this work, a visco-elastic matrix is reinforced with piezoelectric fibers and the overall electro-visco-elastic homogenized properties are computed using a Representative Volume Element (RVE). The elastic, piezoelectric and dielectric constants will be extracted by applying the proper loading and periodic boundary conditions on the RVE. Since the visco-elastic modulus is time (and frequency) dependent, the overall homogenized properties will also be time and frequency dependent. The frequency dependent properties are determined by frequency response studies for a combination of loading and boundary conditions. A parametric analysis will be performed to study the effect of frequency and piezoelectric fiber volume fraction on the homogenized properties. The problem is covered by the MEMS Module, which has the piezoelectric effect and solved in the frequency domain. The main advantage of COMSOL Multiphysics® will be the flexibility to input frequency-dependent material properties and the direct calculation of the homogenized complex material coefficients. The results will set a new benchmark for validating new concepts in the field of piezoelectric composites.