Weighted relaxed micromorphic model for modeling adaptive piezocomposite materials

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The relaxed micromorphic continuum model with weighted free and gradient micro-inertia is used to describe the dynamical behavior of an adaptive metacomposite material. The smart material is made of a periodically distributed piezoelectric patches shunted on optimal impedance able to generate extended phononic band gaps.
A Bloch wave analysis is performed to obtain the dispersion curves of the piezoelectric periodic structure. Three different electrical boundary conditions are also introduced: free of charge (Neumann condition), zero voltage (Dirichlet condition) or optimal shunts (Robin Condition). A linear-elastic, isotropic, relaxed micromorphic model including both a free micro-inertia and a gradient micro-inertia is used to fit dispersion curves of the three different synthetized behaviors. The parameters of the relaxed model, which are independent of frequency, are then calibrated on the dispersion curves showing an excellent agreement. The obtained micromorphic model of the open loop systems with zero current and voltage are also compared with the optimally controlled one. Then one can point out model sensitivity from electric boundary condition that can be linked to specific internal model's degrees of freedom.
This paves the way of designing morphologically complex adaptive meta-structures which make use of the chosen piezoelectric coupling as the basic building block forcontrolling its ability of "stopping" elastic wave propagation at the scale of the structure.