On effective properties of beam-lattice structures made of flexoelectric materials

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Abstract

Flexoelectricity expresses a general property of all dielectrics and relates to the dependence of the electric polarization with gradient of strain. Despite the magnitude of the flexoelectric effect being rather small it could be significant and even dominant at small scales where the strain gradients are important. This phenomena is recently used for manufacturing of NEMS and MEMS as sensors, energy harvesters and actuators.

As flexoelectricity is well pronounced in case of bending dominant structures, here we consider effective properties of beam-lattice structures made of flexoelectric materials. Among examples of such materials it is worth to note collagen fibers which are the most abundant proteins in mammals and other animals.

We discuss effective properties of a particular class of beam-lattices structures called pantographic lattices. The aim of the lecture is to discuss the effective pizezoelectric properties of these structures. Following [1, 2] we derive effective piezoelastic and elastic moduli at the macroscale. In particular, we show that the piezoelectric moduli appear as a result of homogenization of the pantographic beam-lattice under some symmetry constraints. In other words, the microstructure should result in non-centrosymmetric properties at the macroscale.

• Eremeyev, V.A., Ganghoffer, J.F., Konopińska-Zmyslowska, V. and Uglov, N.S., 2020. Flexoelectricity and apparent piezoelectricity of a pantographic micro-bar. International Journal of Engineering Science, 149, 103213.

• Malikan, M. and Eremeyev, V.A., 2020. On the dynamics of a visco–piezo–flexoelectric nanobeam. Symmetry, 12(4), 643.

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