Elastic wave propagation in non-centrosymmetric and chiral architectured materials: insights from strain gradient elasticity

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Abstract

The study of elastic wave propagation is a fundamental tool in different fields, from non-destructive damage evaluation (NDE) to ultrasonic imaging. Usually NDE and characterisation techniques rely on inversion methods based on homogenised theories, that are valid only when the wavelength of the perturbation is considerably larger than the characteristic size of the heterogeneities of the materials. When the wavelength approaches this characteristic size, an upscaling occurs and mesoscopic effects can be transferred to the macro-scale. In this case, classic models used in the aforementioned inversion procedures can fail to predict the correct response [1] and they need to be improved [2].

In this work, we address those architectures for which the unit cell does not have any centre of inversion (non-centrosymmetric) nor symmetry plane (chiral). It will be shown that un- conventional effects, in terms of dispersion and polarisation, can be observed even for large wavelengths. We will also show that, in order to describe these materials using an equivalent homogeneous continuum, the use of an enriched or generalised theory, such as the strain gradient elasticity, is mandatory. Moreover, the analysis of the generalised acoustic (or Christoffel) tensor defined in this framework can give a useful insight on the dynamic features of the architectured material. The delastodynamic behaviour of representative triply periodic cubic architectured materials will be detailed.

Rosi, G., Auffray, N. and Combescure, C. (2020) On the Failure of Classic Elasticity in Predicting Elastic Wave Propagation in Gyroid Lattices for Very Long Wavelengths. Symmetry 12, 1243.

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