Effective Dynamic Moduli and Density of Elastic Composites in Two Dimensions

Mihai Caleap

Department of Mechanical Engineering, University of Bristol, Queens Building, University Walk, Bristol BS8 1TR, U.K.

A multiple scattering theory is developed to predict the effective dynamic material properties of elastic composites in two dimensions. The system consists of cylindrical scatterers distributed randomly in an elastic solid. Scatterers can be homogeneous inclusions, layered, shell-like with encapsulated liquids or gas, non-absorbing, or absorbing.

The coherent wave propagation in the elastic composite is analyzed under the quasi-crystalline approximation. The effective medium that is equivalent to the original composite material is a medium with space and time dispersion, and hence, its parameters are functions of frequency of the incident field. Albeit the effective medium is homogeneous and isotropic, its effective dynamic moduli and density depend on the type of propagating wave, e.g., they are different for longitudinal and transverse incident waves. However, they coincide in the long wave region as expected on physical grounds. Furthermore, the effective material properties are found to be complex-valued, in addition to their dynamic nature.

In the low frequency, long wave limit the effective bulk modulus, mass density and shear modulus are independently determined by the monopolar, dipolar and quadrupolar scattering coefficients of the embedded cylinders alone, respectively.

The emerging possibility of designing composite materials to form elastic metamaterials is discussed. The theory provides a convenient tool to test ideas *in silico* in search for new metamaterials with desired properties.

Oral Presentation Preferred

Email: Mihai.Caleap@bristol.ac.uk