Effective elastic constants for fibrous random composites

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Classical theory of composites amounts to the celebrated Maxwell formula, also known as Clausius–Mossotti approximation. Actually all modern selfconsistent methods (SCM) perform elaborated variations on the theme and are justified rigorously only for a dilute composites when interactions among inclusions are neglected. In the same time, exact and high-order formulas for special regular composites which go beyond SCM were derived. Basing on the MMM principle by Hashin and the theory of homogenization we follow the method of random constructive homogenization developed in [1]. Consider 2D multi-phase random composites with different radii circular inclusions located at the sites of hexagonal (triangular) lattice. The inclusions are embedded into the matrix with different elastic properties. Plane strain elastic problem is solved for such a composite. The effective shear and bulk moduli are obtained in the form of power series in the inclusions concentration f. The coefficients of this series are written in analytical form, with the coefficients expressed through the elastic constants of components. New analytical formulae for the effective constants are deduced up to arbitrary $O(f^n)$ for macroscopically isotropic composites. We derive general analytical formulae for the local fields and for the effective constants in 2D random composites. We consider examples of simulated random media and application of the derived symbolic-numerical algorithms to them.

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