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Docenta Igora Sevostianova

(Department of Mechanical Engineering, NMSU, Las Cruces, NM 88001, USA)

na tému

QUANTITATIVE CHARACTERIZATION OF MICROSTRUCTURES AND CROSS-PROPERTY CONNECTIONS

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Abstract:

Proper quantitative characterization of microstructures, for the purpose of modeling the effective properties, is discussed. This is a broad subject that covers different physical properties (elastic, conductive, transport, etc.), as well as various types of microstructures. The presentation focuses on microstructures that can be characterized as continuous matrices containing isolated inhomogeneities of diverse shapes, properties and orientations. We address their proper quantitative characterization in the context of elastic and conductive properties (transport and fracture-related properties are also briefly discussed).

We discuss similarities and differences between microstructural parameters intended for different physical properties. The possibility of *explicit cross-property connections* between two physical properties depends on whether the proper microstructural parameters for these two properties are sufficiently similar.

In the presentation, approximate connections between conductivities and elastic compliances are discussed and specified for several heterogeneous anisotropic microstructures and verified by comparison with experimental data. The tensor of elastic compliances is expressed in terms of the conductivity tensor in the closed form. The cross-property connections are derived in the framework of non-interaction approximation. In the practical cases, when the interactions between inhomogeneities cannot be neglected, we hypothesize that the interactions affect both groups of properties – elastic and conductive – in a similar way, so that the cross-property correlations continue to hold, although this approximation may yield substantial errors for each of the properties *separately* (this idea was first suggested by Bristow, 1960 for a material with randomly oriented microcracks). This assumption is confirmed by comparison with experimental data on various materials: plasma sprayed ceramic coatings, short glass fiber reinforced thermoplastics and aluminum foams. The similar type of cross-property connection is also obtained for granular materials.