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COMPUTATIONAL METHODS AN ENHANCED PROPERTIES OF COMPOSITES WITH FRACTAL MULTISCALE MICROSTRUCTURE

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In this work we consider composites with hierarchical microstructure in which inclusions form stochastic fractals. In such materials the amount of geometrical detail observed in the microstructure increases from scale to scale in a self-similar manner, they lack characteristic length scales and the Hausdorff dimension is smaller than that of the embedding space. They are prototypical examples of problems without scale decoupling. We aim at developing methods leading to the solution of boundary value problems defined over such composite domains.

A technique based on the stochastic finite element method, implemented with the aid of advances made in the spectral decomposition of the fractal domain problem will be presented [1,2].

Further, we study [3] the difference in the macroscopic behavior of composites with fractal microstructures, and those of same filler size and volume fraction, but in which inclusions are randomly distributed in the matrix. To this end, we study numerically the elastic-plastic and damping response of random microstructures, and of microstructures with exponential and power law spatial correlations. We show that as the range of spatial correlations increases, gains are observed in most macroscopic properties. Significant improvements are observed in the damping behavior. These results are important for the mescoscale design of nanocomposites and other applications.

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