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The Elastic Field of a Nano-Pore, and the Effective Modulus of Composites with Nano-Pores

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Abstract : The composite materials with pores have the characteristics of light weight, sound insulation, and heat insulation, and have broad prospects in many fields, including aerospace. In general, the stiffness of such composite is less than the stiffness of the matrix material, limiting their applications. In this paper, we establish a theoretical model to analyze the deformation mechanism of a nano-pore. The interface between the pores and matrix material is described by the Gurtin-Murdoch model. By considering scale effect related with current deformation, we estimate the effective mechanical properties (e.g., effective shear modulus and bulk modulus) of a composite with nano-pores. Due to the scale effect, the elastic field in the composite was changed and local hardening was observed around the nano-pore, and the effective shear modulus and effective bulk modulus were found to be a function of the surface energy. The effective shear modulus increase with the surface energy and decrease with the size of the nano-pores, and the effective bulk modulus decrease with the surface energy and increase with the size of the nano-pores. These results have potential applications in the nanocomposite mechanics and aerospace field.

Keywords : composite mechanics, nano-inhomogeneity, nano-pores, scale effect
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