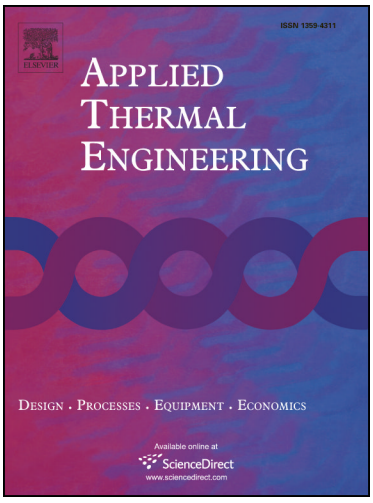

Research Paper

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Unit cells of composites with symmetric structures for the study of effective thermal properties

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Abstract

Effective thermal properties of macro composites with symmetric structures can be efficiently calculated by a size-limited representative unit cell. In this paper, a general rule of such unit cell formulation is developed. Two key steps are involved, the identification of structure symmetries and the derivation of boundary conditions, in which the first step build a geometric model while the later one endows the model physical meanings to represent the original structure. The route from the experiment specimen to the unit cell model, especially the evolution of relevant boundary conditions is clarified. The macroscopic heat flux in experiments is defined as symmetric and antisymmetric thermal stimuli by its directions. For three typical translational, reflectional and 180° rotational symmetric structures, the temperature distribution disciplines under different macroscopic thermal stimuli are revealed and summarized as two equations, and can be used to derive boundary conditions of unit cells. An axial study of unidirectional fiber reinforced composite is conducted to demonstrate the difference between the derived and the inappropriate boundary conditions in the physical mechanism point of view. For the transverse direction of the composite, four unit cell models of reducing sizes are established, and the basic process of unit cell formulations and boundary conditions derivations is stated. Then, for more complex satin woven composites, structure symmetries indicated in the 4-, 5-, 6-, 7- and 8-harness textiles are investigated, two unit cells of different sizes are