

Modeling of Coupled Mechanical State and Diffusion in Composites with Impermeable Fibers

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Abstract : During their service life, composite materials are submitted to humid environments. The moisture absorbed by their matrix polymer induced internal stresses which can lead to multi-scale damage and may reduce the lifetime of composite structures. The estimation of internal stresses is based at a first on realistic evaluation of the diffusive behavior of composite materials. Generally, the modeling and simulation of the diffusive behavior of composite materials are extensively investigated through decoupled models based on the assumption of Fickien behavior. For these approaches, the concentration and the deformation (or stresses), the two state variables of the problem considered are governed by independent equations which are solved separately. In this study, a model coupling diffusive behavior with stresses state for a polymer matrix composite reinforced with impermeable fibers is proposed, the investigation of diffusive behavior is based on a more general thermodynamic approach which introduces a dependence of diffusive behavior on internal stresses state. The coupled diffusive behavior modeling was established in first for homogeneous and isotropic matrix and it is, thereafter, extended to impermeable unidirectional composites.

Keywords : composites materials, moisture diffusion, effective moisture diffusivity, coupled moisture diffusion

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