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Effects of Fiber Interaction and Coating on the Stress Transfer in Composites

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In the present work, the stress distribution in discontinuous and continuous fiber-reinforced composites is examined using finite element analyses. In particular, the effects of fiber interaction and fiber coating on the stress transfer in composites are studied. Mechanical loads and residual stresses due to the mismatch in coefficients of thermal expansion of the matrix and the fiber are considered. The microstructure of the composites, including the fiber and matrix properties, matrix dimensions, and fiber aspect ratio are also examined.

It is concluded that the axial stress distributions in the fiber and the matrix are quite uniform but varies dramatically in the fiber end region. The interfacial shear stress is significant in the neighborhood of fiber/matrix interface at the fiber end, and decreases rapidly in the fiber and the matrix regions. Thermal residual effects on the stress distribution in PRD-166/SLS composites are significant. The fiber axial stress is compressive when the thermal residual effects are considered. However, it is tensile if the thermal residual effects are neglected. The stress transfer between the matrix and the fiber increases with an increase in E_f/E_m. An increase in the ratio of composite radius to fiber radius, r_c/r_f, leads to a higher efficiency of the axial stress transfer in composites. However, as r_c/r_f reaches a critical value, the axial stress transfer reaches an asymptotic value. The stress transfer in composites with high fiber aspect ratio l_f/r_f is more effective than that with low l_f/r_f. The presence of carbon coating in SiC_f/SiC composites may encourage interface cracking if the interface crack propagates under Mode I. Since the axial stress in the matrix of coated SiC_f/C/SiC is lower than that of uncoated SiC_f/SiC, the matrix cracking stress, upon mechanical loading, of SiC_f/C/SiC may be higher than that of SiC_f/SiC. In comparison with carbon-coated composites, the presence of $MoSi_2$ coating in composites may reduce the fiber stress, and significantly increase the axial stress in the coating and the interfacial shear stress. On the other hand, the presence of carbon fiber in composites may induce high tensile radial stress in the coating and increase the interfacial shear stress. A thick fiber coating may result in high axial stresses in the fiber and coating. The interfacial shear stress and matrix stress decrease with an increase in coating thickness.

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