

Modulation of the Interphase in a Glass Epoxy System: Influence of the Sizing Chemistry on Adhesion and Interfacial Properties

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Abstract : Glass fiber-reinforced composite materials have gradually developed in all sectors ranging from consumer products to aerospace applications. However, the weak point is most often the fiber/matrix interface, which can reduce the durability of the composite material. To solve this problem, it is essential to control the interphase and improve our understanding of the adhesion mechanism at the fibre/matrix interface. The interphase properties depend on the nature of the sizing applied on the surface of the glass fibers during their manufacture in order to protect them, facilitate their handling, and ensure fibre/matrix adhesion. The sizing composition, and in particular the nature of the coupling agent and the film-former affects the mechanical properties and the durability of composites. The aim of our study is, therefore, to develop and study composite materials with simplified sizing systems in order to understand how the main constituents modify the mechanical properties and the durability of composites from the nanometric to the macroscopic scale. Two model systems were elaborated: an epoxy matrix reinforced with simplified-sized glass fibres and an epoxy coating applied on glass substrates treated with the same sizings as fibres. For the sizing composition, two configurations were chosen. The first configuration possesses a chemical reactivity to link the glass and the matrix, and the second sizing contains non-reactive agents. The chemistry of the sized glass substrates and fibers was analyzed by FT-IR and XPS spectroscopies. The surface morphology was characterized by SEM and AFM microscopies. The observation of the surface samples reveals the presence of sizings which morphology depends on their chemistry. The evaluation of adhesion of coated substrates and composite materials show good interfacial properties for the reactive configuration. However, the non-reactive configuration exhibits an adhesive rupture at the interface of glass/epoxy for both systems. The interfaces and interphases between the matrix and the substrates are characterized at different scales. Correlations are made between the initial properties of the sizings and the mechanical performances of the model composites.

Keywords : adhesion, interface, interphase, materials composite, simplified sizing systems, surface properties

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