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Using 3-Glycidoxypropyltrimethoxysilane Functionalized SiO2 Nanoparticles to Improve Flexural Properties of Glass Fibers/Epoxy Grid-Stiffened Composite Panels

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Abstract : Lightweight and efficient structures have the aim to enhance the efficiency of the components in various industries. Toward this end, composites are one of the most widely used materials because of durability, high strength and modulus, and low weight. One type of the advanced composites is grid-stiffened composite (GSC) structures, which have been extensively considered in aerospace, automotive, and aircraft industries. They are one of the top candidates for replacing some of the traditional components, which are used here. Although there are a good number of published surveys on the design aspects and fabrication of GSC structures, little systematic work has been reported on their material modification to improve their properties, to our knowledge. Matrix modification using nanoparticles is an effective method to enhance the flexural properties of the fibrous composites. In the present study, a silane-coupling agent (3-glycidoxypropyltrimethoxysilane/3-GPTS) was introduced onto the silica (SiO2) nanoparticle surface and its effects on the three-point flexural response of isogrid E-glass/epoxy composites were assessed. Based on the fourier transform infrared spectrometer (FTIR) spectra, it was inferred that the 3-GPTS coupling agent was successfully grafted onto the surface of SiO2 nanoparticles after modification. Flexural test revealed an improvement of 16%, 14%, and 36% in stiffness, maximum load and energy absorption of the isogrid specimen filled with 3 wt.% 3-GPTS/SiO2 compared to the neat one. It would be worth mentioning that in these structures, considerable energy absorption was observed after the primary failure related to the load peak. In addition, 3-GPTMS functionalization had a positive effect on the flexural behavior of the multiscale isogrid composites. In conclusion, this study suggests that the addition of modified silica nanoparticles is a promising method to improve the flexural properties of the grid-stiffened fibrous composite structures.

Keywords : isogrid-stiffened composite panels, silica nanoparticles, surface modification, flexural properties
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