Transparent Glass Fiber-Reinforced Poly(styrene)-*co*-Poly(methyl methacrylate)-Based Nanocomposites

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Transparent fiber-reinforced polymer composites are designed for high mechanical and thermal performance. In this study, it was aimed to elaborate optically transparent glass fiber-reinforced polymer composites as a building component of a futuristic architecture project. E-glass fabrics were used as fiber reinforcement. The polymeric matrix, which has exactly the same refractive index value with glass fibers, was synthesized with a calculated ratio of the styrene and methyl methacrylate monomers. Alternatively, thermoset polymer matrices using tri-, tetra-, and octa- methyl methacrylate functionalized Polyhedral Oligomeric Silsesquioxanes (POSS) molecules were synthesized. The wt.-% of each POSS molecule was decided according to the refractive index matching between each thermoset polymer matrix and glass fabric. As a result, fully transparent polymers with different crosslinking densities and different wt. % of the POSS cages were produced.

Each of these optically transparent composites was evaluated according to their light transmittance, haze, clarity, the coefficient of thermal expansion (CTE), thermo-optic coefficient, as well as for their mechanical and thermal degradation properties. Decreasing the coefficient of thermal expansion is a major issue for polymer composites. Compared to inorganic materials like glass, polymeric materials have a larger coefficient, which makes them thermally unstable for critical applications. Thus, glass fiber-reinforced composites need to be tested in terms of CTE performance. Likewise, the thermo-optic coefficient is a prominent parameter in terms of evaluating the thermal interval, in which the composite will remain its optical transparency. By using this parameter, we produced composites with temperature-dependent transparency. With the help of the crosslinking density and the POSS cage ratio, it is possible to vary this parameter in a controlled manner within a given range.