Effects of acid, alkaline, and seawater aging on the mechanical and thermomechanical properties of glass fiber/epoxy composites filled with carbon nanofibers

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ABSTRACT

Owing to the superior corrosion resistance, fiber-reinforced polymer (FRP) composites are the prime choice of structural materials for various marine and chemical industries, where there is a long-term direct contact of the components takes place with corrosive fluids. In this present work, glass fiber/epoxy (GE) composites have been fabricated with and without carbon nanofibers (CNFs), and aging has been carried out in acidic (pH = 1), seawater (pH = 8.2), and alkaline (pH = 13) solutions for 150 days. The resistance of CNF-filled GE composites toward the corrosive fluids has been evaluated in terms of alteration in the mechanical (flexural), microstructural (fractography analysis by field emission scanning electron microscope), and thermomechanical (dynamic mechanical analysis) behaviour of the materials. It is revealed that as the immersion time increases, there is a continuous decrement in flexural strength and modulus, and glass-transition temperature (T_g) of all the materials in all these solutions. Compared to the 1% CNF-filled GE composite, control GE composite showed more degradation in the case of alkaline aging and seawater aging. Maximum reduction (56%) in the strength of GE composite was observed due to 150 days of alkaline aging. However, the control GE composite showed better resistance to the acidic solution than that of CNF-filled GE composite. Possible failure modes, changes in the chemistry of the material due to aging have been studied by fractography analysis.

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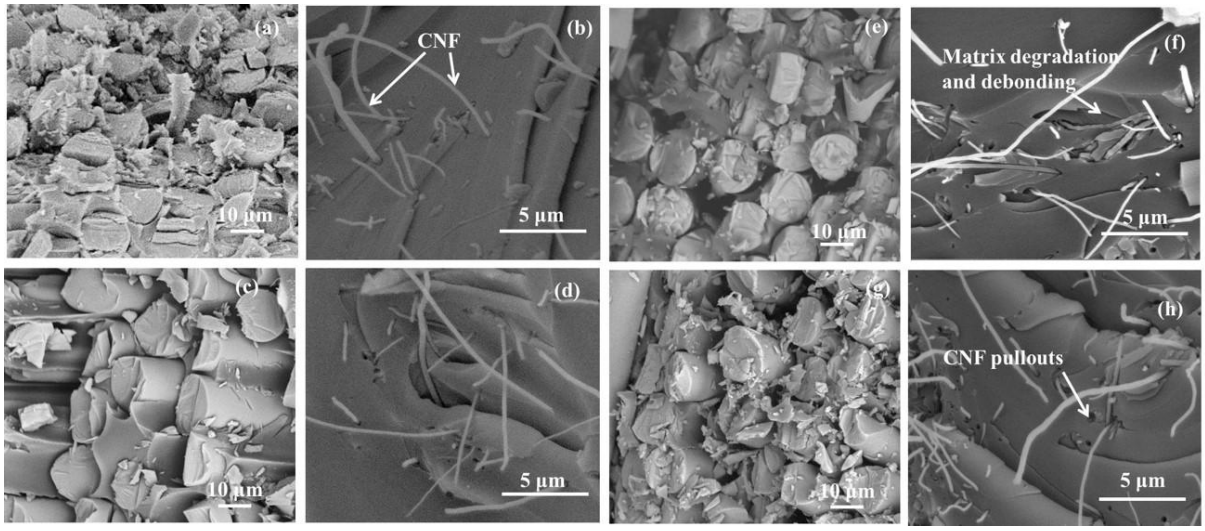
(a)
10 µm
CNF
(b)
5 µm
(c)
10 µm
Matrix degradation
and debonding
(f)
5 µm
(c)
10 µm
(d)
5 µm
(g)
10 µm
(h)
CNF pullouts
5 µm