

Corrosion behaviors of basalt fiber exposed to the chemicals

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Abstract: Basalt fiber (BF) has been extensively used in construction, aerospace, and transportation. During the service life, the fiber experiences various chemical conditions, which leads to the failure of the composites reinforced by BF. This report will present our findings on studying the morphology and mechanical property of BF processed in different chemical conditions. Using the Taguchi method with orthogonal design, we investigated the effect of corrosive solution, temperature, and time on the surface morphology and strength of BF. It was found that when BF was exposed to the acids (HCl, H₂SO₄, HNO₃), immersion time significantly affected the strength of BF due to the exchange between the H⁺ and metal ions on the fiber surface. In H₂SO₄, the formation of CaSO₄ aggravated the leaching of Ca²⁺, severely reducing the strength of the fiber. The acid-induced low-energy crack opening was responsible for the formation of spiral cracks on the fiber surface. Under alkali conditions (NaOH, KOH, Ca(OH)₂), the main factor affecting the strength of BF was the immersion time in NaOH, while the immersion temperature was the most predominant one in KOH and Ca(OH)₂. Generally, as the Si-O-Si bond in the fiber was attacked by OH⁻, the leached Fe and Mg ions reacted with OH⁻ to form insoluble hydroxides. Interestingly, the compression stress induced by Na⁺/K⁺ exchange on the BF surface improved its mechanical property. Additionally, the corrosion of BF in simulated seawater was a competitive process, including the fiber strength enhancement arising from ion exchange between Na⁺/K⁺, deposition of insoluble substances, and the reduced fiber strength due to the damage of Si-O-Si structure. To protect the fiber from corrosion, nanocomposite sizing containing Si-based nanosheet was applied on fiber surface. The anti-corrosion performance of BF towards seawater was improved on account of the barrier and sacrificial effects derived from the nanosheet in the sizing.

Keywords: Basalt fiber, Mechanical performance, Surface morphology, Chemical corrosion, Nanocomposite sizing