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SiAlON nanoparticles effect on the behaviour of epoxy coating

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Abstract In this work, the influence of SiAlON nanoparticles loading level (0–12 wt%) was investigated on the mechanical and chemical properties of epoxy resin-based nanocomposites coatings. The samples were characterized by fracture toughness, chemical, pull off, hardness and abrasion tests, followed by scanning electron microscopy of the fracture surfaces and sample surface after performing a chemical test. Nanoparticles were also characterized by transmission electron microscopy and linear light scattering analysis techniques. Epoxy resin coating based on bisphenol A was treated with polyamine hardener as a curing agent. Fracture toughness measurements were carried out using a single edge notched bend specimens within a three-point bending test at room temperature. Effect of SiAlON nanoparticles on the chemical resistance of epoxy resin was investigated by immersion of samples in 3.5 wt% NaCl solution at 85 °C for 60 days. Results indicated the enhancements in the mechanical properties and chemical resistance of epoxy nanocomposite due to the addition of small parts of SiAlON nanoparticles. The contents of samples with 3 and 5 wt% of SiAlON nanopowders have been considered as optimum contents compared to the other samples. They showed improvement in the crack propagation resistance in chemical solution and fracture toughness tests, both. Enhancment in abrasion resistance was found at either of 3 and 5 wt% SiAlON epoxy nanocomposite samples where they showed 59 and 34% abrasion resistance more than that of the neat resin, respectively.

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Introduction

Epoxy resins are some of the most important thermosettings that are widely used in industrial applications, such as coatings to protect the steel pipeline [1–3], adhesives [1–3] and electronic devices [1, 2] due to their outstanding processability, excellent chemical resistance, good electrical insulating properties, and strong adhesion/affinity to the heterogeneous materials [4, 5]. Nonetheless, the successful application of epoxy coatings is often hampered by their susceptibility to damage by surface abrasion and wear [5]. They also show poor resistance to the initiation and propagation of cracks [5–7] due to their cross-linked molecular structures [8].

In recent years, nano particles are being used as advanced fillers to improve the mechanical and chemical properties of the epoxy resin [1, 2]. In general, factors such as the extent of the adhesion of the filler particles to the epoxy matrix, as well as, their shape and size have been found to affect the mechanical properties of the epoxy-based composites [1, 9]. The dispersed fine particles in coatings can fill cavities [10] and cause crack bridging [5, 10], crack deflection [1, 5] and crack bowing [1, 5, 10]. Nanoparticles can also prevent epoxy disaggregation during curing, resulting in a more homogenous coating. They reduce the trend of blistering or delaminating in coatings, as well [5].

Mechanical and chemical properties of polymers are generally improved by the addition of inorganic additives [2, 3, 11]. Organic–inorganic composites can improve the interfacial adhesion between the polymer matrix and the