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Effect of perlite particle contents on delamination toughness of S-glass fiber reinforced epoxy matrix composites

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ABSTRACT

The effects of perlite particulate-filler on the mode I and mode II interlaminar fracture and mechanical behavior of glass fabric/epoxy composites were studied. Composite specimens for double-cantilever beam (DCB), end-notched flexure (ENF) tensile and flexural tests were prepared and tested according to ASTM standards with perlite contents of 1, 3, 5 and 10 wt%. The optical and scanning electron microscopes images were described the mechanisms of mode I and II interlaminar fracture. The results indicated that the mode I and mode II interlaminar fracture toughness were optimum at perlite content of 3 wt% with increment of 39.9% and 72.3%, respectively. The tensile strength and flexural properties reached maximum values at perlite content of 1 and 5 wt%, respectively.

*Keywords***:** Perlite; Glass fiber; Epoxy; Mechanical properties; Interlaminar fracture; Delamination.

1. Introduction

The preferred properties and useful characteristics of glass fibers reinforced polymer (GFRP) composites like high modulus, strength, good impact resistance and high resistance to environmental make suitable for many applications such as piping, automobile, aircraft and marine industries [1-2]. Nevertheless, GFRP has poor resistance to delamination [3]. This issue may be ascribed to the lack of fibers reinforcement oriented in the laminate depth for effective transverse of the applied force that can be circumvented by Z-fiber stitching or pinning other fibers to join layers [4-6]. However, tensile properties of composites reduce by this technique and need other manufacturing procedures [7, 8]. Epoxy resins have been usually used in GFRP laminates for above applications due to low shrinkage during curing, high corrosion resistance and working capability under various conditions [9]. Therefore, researchers used high performance epoxy like dendritic hyperbranched to improve delamination toughness, but its needs more improving [10]. The other toughing method is including particulate-filler within laminate composite, which some researchers used thermoplastics and rubber fillers [11, 12]. However, when high molecular weight of thermoplastics and rubber particles are incorporated, the epoxy viscosity is raised and lead to difficulties in composite lamination process. Although the interlaminar fracture toughness is usually elevated with previous technique, the stiffness and strength are reduced.

The rigid inorganic micro- and nano-particles have been used in fabrication of composite laminates in recent years due to improving the composites mechanical properties and interlaminar fracture [13-33]. In addition, some waste and cheap fillers can reduce the cost of fabrication and product [34].