Accepted Manuscript

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PII: S0266-3538(16)31068-5

DOI: 10.1016/j.compscitech.2016.08.022

Reference: CSTE 6501

To appear in: *Composites Science and Technology*

Received Date: 21 April 2016

Revised Date: 22 August 2016

Accepted Date: 25 August 2016

Please cite this article as: Leopold C, Liebig WV, Wittich H, Fiedler B, Size effect of graphene nanoparticle modified epoxy matrix, *Composites Science and Technology* (2016), doi: 10.1016/j.compscitech.2016.08.022.

Size effect of graphene nanoparticle modified epoxy matrix

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Abstract

The size effect of unmodified and graphene nanoparticle modified matrix fibres is experimentally investigated. Neat matrix fibres show a clear size effect of increasing tensile strength with decreasing volume due to a statistical defect distribution. The nanoparticle modified matrix shows no significant size effect. Nanoparticles act as crack initiators and consume fracture energy. The size of the particles is independent of specimen volume, so that the failure initiating as well as energy absorbing mechanisms are available, independently of the volume. Fractography analysis of SEM images shows different energy dissipation mechanisms such as micro-damage at the graphene particles. Graphene pull-out, layer separation, layer shearing, formation of micro voids as well as crack separation and crack bifurcation are observed that depend on the orientation of the graphite layers to the fracture plane. These mechanisms dissipate energy and so that a graphene nanoparticle modification result in an increased fracture toughness and thus increased strength of an epoxy matrix system if the volume is large enough. The maximum stress in specimen of small volume depends on graphene layer orientation, so that ideally, the covalent bonds of the nanoparticles should be orientated in loading direction.

Keywords: A. Nano particles, B. Stress concentrations, C. Fractography, C. Scanning electron microscopy (SEM)

1. Introduction

As fibre reinforced plastics (FRP) gain increasing importance as load carrying parts in many applications, accurate prediction of strength and failure behaviour becomes increasingly relevant.

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