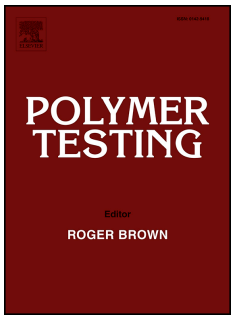
Accepted Manuscript



Fractographic relation between progressive failure and strain measurement techniques for recently developed configuration of carbon fiber/epoxy laminate

Jan Mayén, Arturo Abúndez, Enrique Alcudia, José Antonio Arellano, Jorge Colín, Isa Pereyra, Iván Puente-Lee

PII: S0142-9418(16)30994-1

DOI: 10.1016/j.polymertesting.2016.10.036

Reference: POTE 4816

To appear in: *Polymer Testing*

Received Date: 23 September 2016

Accepted Date: 27 October 2016

Please cite this article as: J. Mayén, A. Abúndez, E. Alcudia, J.A. Arellano, J. Colín, I. Pereyra, I. Puente-Lee, Fractographic relation between progressive failure and strain measurement techniques for recently developed configuration of carbon fiber/epoxy laminate, *Polymer Testing* (2016), doi: 10.1016/j.polymertesting.2016.10.036.

Fractographic relation between progressive failure and strain measurement techniques for recently developed configuration of carbon fiber/epoxy laminate

[1]Jan Mayén*, [1]Arturo Abúndez, [1]Enrique Alcudia, [1]José Antonio Arellano, [1]Jorge Colín, [2]Isa Pereyra, [3]Iván Puente-Lee

[1]Tecnológico Nacional de México/Centro Nacional de Investigación y Desarrollo Tecnológico (CENIDET), Prolongación Palmira s/n es. Apatzingán, Col. Palmira. Cuernavaca, Morelos, México

[2]CIICAp/FCQeI/Universidad Autónoma del Estado de Morelos Av. Universidad 1001 Col. Chamilpa C.P. 62209-Cuernavaca, Morelos. México.

[3]Facultad de Química/ICF/Universidad Nacional Autónoma de México, Coyoacán, D. F. C. P. 04510 México.

**E-mail:* jmayen@cenidet.edu.mx, *Phone/fax:* Tel./fax: +52 777 362-7770 ext. 1408

Abstract

In the present work, fracture mechanisms of newly developed carbon fiber/epoxy laminate $[+75/0/-75]_s$ were assessed by scanning electron microscopy (SEM). The composite strain-stress curves were plotted with displacement information simultaneously acquired from both a tensile testing machine and an extensometer. The strain-stress curve plotted with the displacement data from the machine test showed an average slope change from E_{1m}= 22.783 GPa to E_{2m}= 13.170 GPa on about 65% of the total strain before global failure, while strain-stress curves plotted with displacement data from the extensometer showed one single slope. While results reported in literature related to composite failure mechanisms, where some authors reported a slope change in strain-stress curves associated to progressive failure, experimental evidence in this work for strain-stress curves showed one single slope, indicating that such slope change is due to the strain measuring technique, and not to progressive failure. The fracture surface was studied, and four main features were observed, which were related to failure mechanisms during the uniaxial test. The identified failure mechanisms occurred on a stage above 93% of the total strain before global failure.

Keywords: carbon fiber/epoxy laminates; composites; fractography; tensile failure; SEM

1. Introduction

The development of structural materials is focused on three important properties; Elastic modulus (E), Strength (σ) and Toughness (G) [1]. These give engineers the confidence to select and use a specific material for a specific application, and it may be widely used if these three parameters are fully investigated and characterized. Although the effect of factors such as environment, manufacturing, loading conditions and initial damage state on materials performance is widely understood, there is still a lack of information on material response under specific conditions, which should be thoroughly studied.

There is a vast body of information published in the literature about polymer composites failure theories [1-3]; these are used for prediction on the failure initiation and progressive failure up to the last load. In a review conducted by Daniel *et al* [3], there is a large number of variations in prediction