Accepted Manuscript

Comparison of surface and bulk analytical techniques for the distinct quantification of a moderate thermal pre-load on a carbon fibre reinforced plastic material

S. Eibl

PII: S0141-3910(16)30350-0

DOI: 10.1016/j.polymdegradstab.2016.11.015

Reference: PDST 8113

To appear in: *Polymer Degradation and Stability*

Received Date: 6 September 2016

Revised Date: 20 October 2016

Accepted Date: 20 November 2016

Please cite this article as: Eibl S, Comparison of surface and bulk analytical techniques for the distinct quantification of a moderate thermal pre-load on a carbon fibre reinforced plastic material, *Polymer Degradation and Stability* (2016), doi: 10.1016/j.polymdegradstab.2016.11.015.

Comparison of surface and bulk analytical techniques for the distinct quantification of a moderate thermal pre-load on a carbon fibre reinforced plastic material

S. Eibl
Bundeswehr Research Institute for Materials, Fuels and Lubricants
Institutsweg 1, D-85435 Erding
Tel.: ++49 (0)8122-9590-3521, Fax: ++49 (0)8122-9590-3602
SebastianEibl@bundeswehr.org

Abstract

This work provides a comparison of analytical techniques to separately determine temperature and duration of a thermal pre-load on a polymer matrix composite as well as its residual strength. The aim is to assess selected techniques applied on surfaces and for bulk material to characterize incipient heat damage. The methods are ideally non-destructive such as infrared spectroscopy (IR). A destructive method for bulk material is represented by thermogravimetric analyses (TGA). TGA can be applied independent of accessible surfaces and inhomogeneous polymer distribution. Empirical correlations of the recorded data with mechanical properties allow the assessment of residual strength for a composite with unknown thermal history. Multivariate (chemometric) analyses provide reliable values for time and temperature (average deviation < 10°C) of the thermal pre-load and residual interlaminar shear strength (average deviation < 5%). Bench top and hand held attenuated total reflection (ATR) and diffuse reflectance (DR) IR spectrometers provide similar accuracy. A commercially available composite (HexPly ® M18-1/G939) was investigated. Infrared spectroscopy of bulk material after grinding is identified to provide a high potential of in-service use in aviation.

Key Words

Carbon fibre reinforced plastic material, Thermal properties, non destructive testing, Infrared (IR) spectroscopy, Thermogravimetric Analysis

1. Introduction

The characterization of thermal damage of carbon fibre reinforced plastic (CFRP) material is of major importance, especially for aircraft applications, structural health monitoring and failure analysis [1]. Mechanisms of thermal damage are debonding of fibre and resin due to the preferred degradation of the interphase [2], delamination and formation of cracks [3-5] accompanied by the degradation of the polymer matrix [6, 7].

Methods to evaluate degradation effects are preferably easy, fast, non-destructive and significant [8]. Ultrasonic and thermographic examinations, computer tomography or hammer tapping can only be applied when massive thermal damages by means of defects like delaminations have already occurred in a component [9-11]. For moderate thermal