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Acoustic Emission for Interlaminar Toughness Testing of CFRP: Evaluation of the Crack Growth due to Burst Analysis

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Abstract:

The paper deals with interlaminar fracture toughness testing of three different types of specimens from unidirectional aerospace laminate M21/T800S (autoclaved and hot pressed) and the woven fabric ECG Carbon 12k with respect to the ASTM Standard D 5582.Simultaneously the materials were monitored by acoustic emission to evaluate the results via burst analysis. CFRP-specimens were mounted in a CNC-machining center by a chopper wire. The lower wire was fixed at a load cell (KISTLER 9257 B) to measure the force development. Standard specification the movement speed in z-direction was set to 5 mm/min. The acoustic emission sensor iMPact XS with accuracy is ±5 % with a reference sensitivity of > 1200 pC/N was fixed on the DCB-specimens with a two-sided adhesive tape with thickness of 0,5 mm. The sensor iMPact XS has a frequency range from 1 mHz up to 1 MHz limited to a maximum of 500 kHz. It has been found that the material properties correlate well with the results of the acoustic emission analysis. The burst rate reflects the manufacturing processes as it is influenced directly by the fibre bridging which occurs particularly for autoclaved composites. In contrast, the burst energy is not affected by the manufacturing process. It is only depending from the matrix properties.

Keywords: DCB; interlaminar toughness testing; acoustic emission; CFRP; burst analysis; crack growth; M21/T800S; ECG Carbon 12k

List of Symbols and Abbreviations

AE	– Acoustic Emission	
DCB	– Double Cantilever Beam	
CRFP	– Carbon Fibre Reinforced Polymers	
G_{1C}	– Strain Energy Release Rate	
NL	– Deviation from linearity (G_{1C})	
VIS	– Visual onset of delamination (G_{1C})	
5%/max	– Compliance increase by 5% or maximum value of load (G_{1C})	
MBT	– Modified Beam Theory	
UD	– Unidirectional layer orientation	
f_{peak}	– Peak frequency of a burst	[Hz]
E	– Released burst energy	[V²s]