IDENTIFICATION OF DAMAGE ONSET IN CFRP LAMINATES UNDER TENSION-TENSION FATIGUE USING ACOUSTIC EMISSION ANALYSIS

N. Schorer[1*], M. G. R. Sause[1]

[1]*Institute of Materials Resource Management, University of Augsburg, Am Technologiezentrum 8, 86159 Augsburg, Germany*
**nora.schorer@mrm.uni-augsburg.de*

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Abstract

Mechanical testing often targets a global material characterization, focusing on the final failure of the material and disregards the damage history. In the field of fatigue testing, global material characterization is very time-consuming and costly due to the necessary test campaigns. With the help of methods such as digital image correlation and acoustic emission analysis, the occurrence of damage and its temporal onset can be determined at a very early phase of load cycles. This offers great potential to understand and assess more about the local damage accumulation and mechanical behavior long before the occurrence of final failure.

In order to make conclusions about the occurrence of microscopic damage, an investigation of quasi-isotropic CFRP laminates under tension-tension fatigue in the high cycle range (up to 1 million cycles) at 5 Hz with accompanying acoustic emission analysis was carried out. This investigation was preceded by a complete mechanical analysis of static tensile tests on the same laminate using digital image correlation and acoustic emission analysis, from which damage onsets were determined. These onsets correspond respectively to microscopic and macroscopic failure mechanisms and were used to determine the test strategy in the form of suitable load amplitudes for the cyclic tests. In addition, static tensile tests using the same secondary methods were carried out to evaluate the residual strength and the damage onsets after cyclic loading.

The investigations show, similar to static loading, that there are indications of local failure during fatigue loading that occur as soon as the damage onset found in the static tests is exceeded and does not occur as long as the damage onset is not exceeded. This leads to the conclusion that acoustic emission analysis in the field of fatigue testing of composites is a true asset that can be used to transfer damage activity measurements from static investigations to fatigue testing.