Success Story
COMET

FFG

ZERSTÖRUNGSFREIE PRÜFUNG UND TOMOGRAFIE

ZPT+
K-Project for non-destructive testing and tomography Plus - Quantitative and in-situ methods for inspection and materials characterization
Programme: COMET – Competence Centers for Excellent Technologies
Programme line: K-Projects
COMET subproject, duration and type of project:
ZPT+, [09/2014 – 08/2018], multi-firm

3D characterisation of damage mechanisms for fibre reinforced polymers

Progression on the non- destructive testing method computed tomography (CT) was made for the expressive analysis of fibre reinforced polymers. In order to produce new components in an efficient and load demanding way, the mechanisms that lead to damage of the material or component were investigated. New methods allow for mechanical testing within the CT device and therefore a detailed description of damage mechanisms of fibres and polymer. The results contribute to weight reduction and efficient manufacturing and furthermore to fuel reduction. FH Wels has published results at conferences and in scientific journal articles.

Polymers for structural components

Structural light weight design is an important factor for transportation, automotive- and aeronautic industry. New materials or the optimisation of existing material concepts should lead to a reduction of weight and furthermore to a reduction of fuel consumption. This task can only be fulfilled by the optimisation of manufacturing techniques and methods for component design together with the optimisation of testing procedures. This complementary approach is necessary for the detection and characterisation of defects and distribution of reinforcing materials for the final product.

Considering these requirements, short and long fibre reinforced polymers are very important for structural light weight design. Fibres with a length of some 100 microns up to a few centimetres can improve strength and stiffness of polymers and make the usage of such materials possible for highly loaded components.

3D characterisation under load

As part of this project, non- destructive testing methods were developed for the three dimensional characterisation of fibre reinforced polymers. Important parameters like fibre orientation, fibre length and fibre content can be determined with high accuracy.

The testing method used is industrial computed tomography (CT). Especially glass fibres within a thermoplastic matrix can be scanned with high contrast and high resolution. An algorithm for 3D data analysis that was developed by FH Wels, delivers all important information about the fibres.

Beyond that it is possible to investigate mechanisms that lead to damage, three dimensionally. A standard tensile test is conducted to determine mechanical parameters like tensile strength and modulus of elasticity. An increasing force is applied until final fracture of the specimen.

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The same experiment is transferred into the scanning chamber of the CT device. This allows for the three dimensional characterisation by CT during tensile testing. (Fig.1)

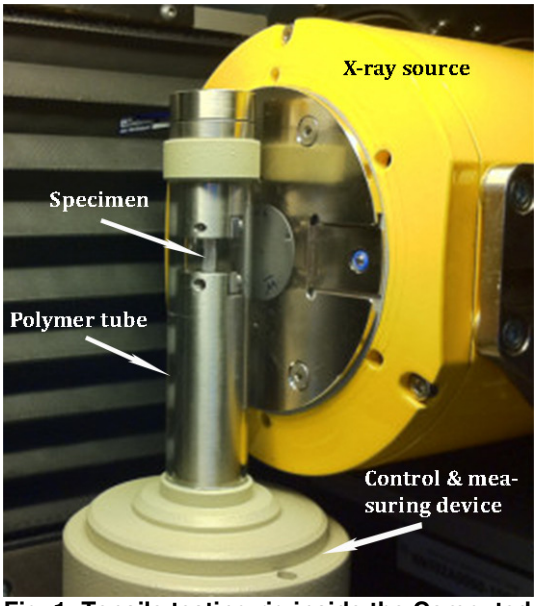

Fig. 1: Tensile testing rig inside the Computed tomography device (Copyright FH Wels)

Beside high resolution and an adequate tensile testing rig, segmentation and visualisation of defects are important aspects the project is addressing. (Fig. 2)

Impact and effects

The development of the introduced concepts strengthens the research activities of the University of Applied Sciences Upper Austria, Wels Campus by publications of scientific contributions in journals and the attendance of international conferences.

For the involved companies the research results are a very important base for the improvement of their material systems and components. Using the gained, very detailed knowledge about damage mechanisms it will be possible in the near future, to reduce safety factors and to manufacture components, usually made of heavier metals, out of lighter polymers.

Especially for automotive industry these developments are of extraordinary interest because light weight design and cost efficiency are crucial parameters. Interior components (e.g. dashboard holders, door fairings) but also structural components in the motor compartment (e.g. pendulum strut, transmission cross beam) are manufactured of fibre reinforced polymers.

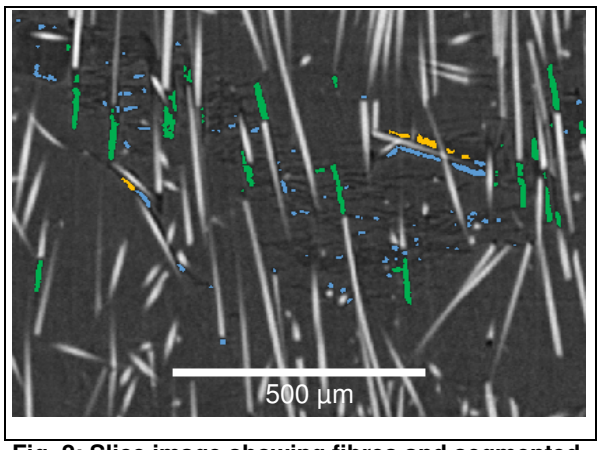

Fig. 2: Slice image showing fibres and segmented damage (Copyright FH Wels)

The newly developed components allow for a reduction of weight up to 15 % and contribute to a reduction of fuel consumption and a reduction of production costs.

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