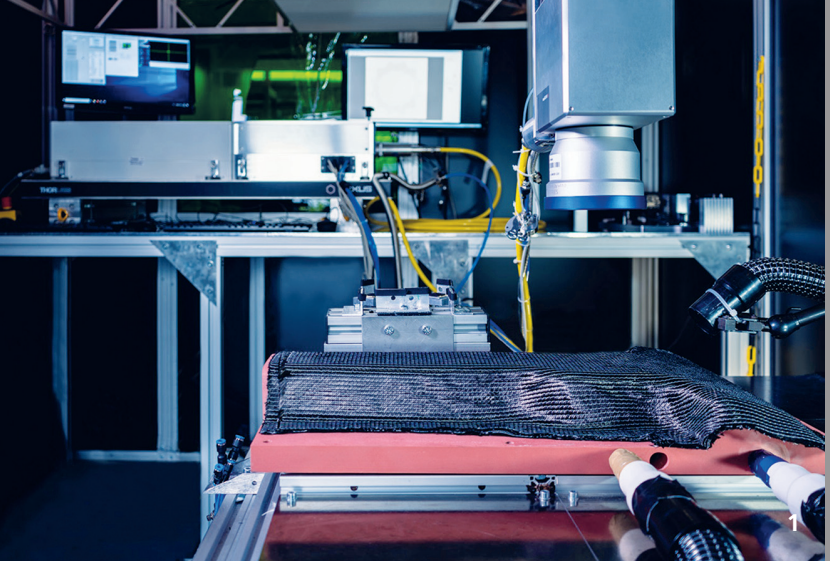

ROBOT-GUIDED LASER DRILLING OF CFRP PREFORMS

Task

When metallic force transmission elements are integrated into CFRP components as detachable connections, the components are commonly drilled, placing special demands upon the production technology. Defects such as thermal damage and delamination must be prevented at all costs since both the carbon fibers and the complex process chain for the production of CFRP components are costly. Ultrashort pulse (USP) laser drilling is already suitable for producing high-quality and precise holes on the dry preform. This process-safe material processing, however, has so far failed as it lacks a suitable ablation process for 3D-formed CFRP semi-finished products.

Method

Within the publicly funded CarboLase project, Fraunhofer ILT together with AMPHOS has developed a technology to guide the USP laser radiation from the beam source via a hollow core fiber to a galvo scanner. The scanner is mounted as a processing head on an articulated arm robot. Thanks to the integrated beam stabilization, the mirrorless beam guidance can be used to dynamically move the scanner over a CFRP preform. In and above the forming tool, on which the CFRP preform is fixed, suction devices are installed to remove particles and vapors. By means of scanner processing, any 2.5D contours adapted to the later load case can be introduced into the preform. After the drilling process, the scan head is removed and an effector is attached with which load input elements are inserted into the drilled preform. In the subsequent process step, the functionalized preform can be infused with the matrix material and then cured.

Results

Accurately fitting holes can be produced since the laser ablation is precise and does not generate any defects. The subsequent matrix infusion creates a multi-material connection without needing additional adhesives. The inserts bonded directly to the matrix material achieve up to 50 percent higher maximum pull-out force compared to conventionally manufactured components with glued-in inserts.

Applications

The dynamic USP laser drilling process is particularly useful when processing lightweight components in the aerospace industry as well as for automotive engineering. Since the fasteners are significantly stronger, the highly automatable process can also help save both material and costs in the production of CFRP components.

This project was carried out with funding from the European Regional Development Fund (ERDF) under the funding code EFRE-0800793.

Contact

Dr. Stefan Janssen
Telephone +49 241 8906-8076
stefan.janssen@ilt.fraunhofer.de

Dipl.-Phys. Martin Reininghaus
Telephone +49 241 8906-627
martin.reininghaus@ilt.fraunhofer.de

1 Flexible and automated UKP laser ablation for CFRP preforms, © ITA - RWTH Aachen University.

2 Adhesive-free mounted inserts in a CFRP B-pillar demonstrator, © ITA - RWTH Aachen University.