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Corresponding author: Brandt Lars
e-mail of corresponding author: lars.brandt@dlr.de
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Title
Towards toolless manufacturing of aerospace CFRP components via thermoplastic AFP

Authors
Lars Brandt [1], Dominik Deden [1], Fabian Schühler [1], Michael Vistein [1], Philipp Gänswürger [1]*

** Corresponding author*
[1] German Aerospace Center (DLR), Center for Lightweight Production Technology, 86159 AUGSBURG, Germany, lars.brandt@dlr.de

Abstract
Commercial aviation has to reduce its carbon dioxide emissions drastically in the next century to comply with international legal requirements and self-commitments given by the airlines to reduce climate change. In order to reach these goals, aviation industry has to improve propulsion, substitute fossil fuels and reduce structural weight. A viable approach is the comprehensive use of carbon fiber reinforced plastics (CFRP) in modern aircrafts. However, these concepts have still not been applied to single aisle aircrafts, which account for a significant proportion of new aircrafts (approx. 80%) [1].

Enhanced manufacturing processes for CFRP components and optimized materials are necessary to meet the required high production rates. A reduced consolidation time, out of autoclave capabilities as well as increased component size are all highly desired for this reason. Additionally, high investment costs should be avoided and new processes require a high flexibility with regards towards different designs in order to be ready for the next generation of aircrafts. Due to increasing material and energy costs high efficiency and recyclability are beneficial. Manufacturing techniques that improve all these key success factors have to be identified, developed and implemented for narrow body aircraft production.

Direct consolidation of thermoplastic CFRP via Automated Fiber Placement (AFP) is a highly automated additive process without size restrictions. The use of a laser heating system ensures a local heating and thus a comparatively efficient process. Further, the use of thermoplastic material offers good recyclability. Drawbacks of this technology are isues regarding mechanical performance with knock downs compared to hot pressed laminates and the need of complex molds that constrain design changes. A concept to optimize the process was introduced by Kochoski et al. where the tooling is substituted by a second robot, a dual robot AFP process. Feasibility for the production of complex laminates was shown. In this paper we expand on the concept and validate a setup for dual robot AFP. Manufacturing parameters for a CF/LM-PAEK material are identified and optimized. The setup used is depicted in Figure 1. Temperature gradient measurements are carried out to show the differences in heat transfer and reduced energy consumption compared to a standard AFP setup with metallic mold. Subsequently mechanical characterization for flat panels are conducted to evaluate the possibility to manufacture high quality components.

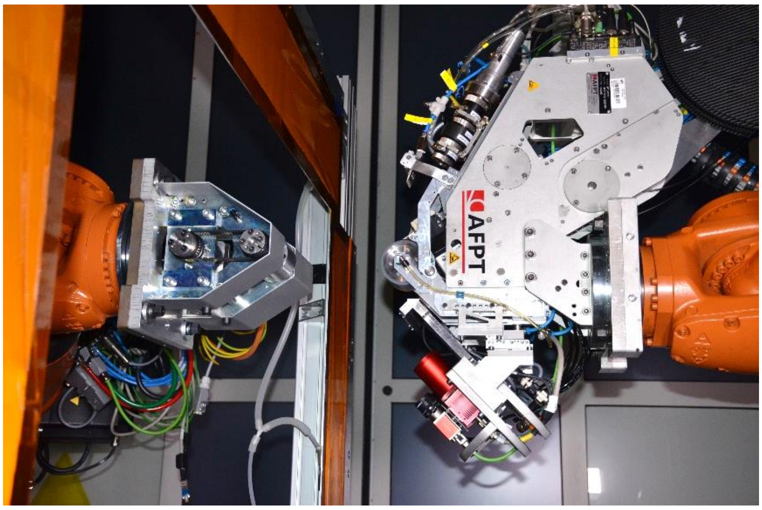

Figure 1: Dual Robot thermoplastic AFP setup

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