AChSo

Automated Chemical Stitching and Preforming

State of the art – Background

In the composite production process chain, the step of preforming is among the most important and also most difficult to automate. During preforming, the flat textile layers are given the final component geometry. The component quality greatly depends whether or not the manufacturing goals in the preforming stage can be reached or not.
Traditionally, the preforming was often done by hand, because of handling issues with dry textiles. In order to lower manufacturing costs and thus introduce composite solutions for more cost sensitive products, automated preforming processes needed to be developed.
For profile geometries, such as reinforcements of shell structures in aircraft, continuous processes are the most effective. In 2011 a consortium that included Broetje Automation and the research institute Faserinstitut Bremen, introduced a fully automated Continuous Composite Preforming System (CCPS) for dry textiles and was awarded the prestigious JEC Award for this development. The process uses dry textiles to enable energy efficient out-of-autoclave curing processes. To fixate these textiles in their shape and for easier handling, a powdered adhesive was applied to their surface. The Chemical Stitching technology, developed by Fraunhofer ICT, replaces the adhesive powder with points of liquid resin. The adhesive is thus only applied very locally in contrast to the use of the adhesive powder on the entire surface of the textiles.

Objectives

The objective of the project AChSo is to develop a automated continuous process for profile preforms, that is advanced with the newly developed Chemical Stitching. The benefits of this new development are preforms with better permeability, better mechanical properties and less foreign material.
This would enable the mass production of complexly shaped reinforcement profiles that also show exceptional performance. The out-of-autoclave processes that can be used for infiltration and curing these preforms are both more ecological and cost-efficient than prepreg preforms.
The technology will be confirmed by manufacturing aileron spar preforms for the Eco-Design for Airframes demonstrator, with the geometries of the Do 228NG.

Description of work

Within the CleanSky project “AChSo” the CCPS is enhanced with module to incorporate the previously described Chemical Stitching technology.

Compared to the binder based continuous preforming system, the most significant change is the integration of the chemical stitching procedure into the process to substitute curing of a binder. Therefore the injectors are introduced after forming the cross-section of the profile.
To minimize the system components the CCPS is adjustable to produce performs for the spar caps and the doublers. Therefore one of the Injectors is rotatable. Hence the system adjustment is very simplified. Via control panel the necessary amount of adhesive is set. To improve the amount of stitching dots double needle injectors are used. Hence two stitching dots are applied on each flange of the L-shaped spar caps. An advantage of this process is that the stability of the preforms is adjustable. It is directly dependet on the amount of stitching dots per length.

To prevent damage of the NCF from the injection needles, the injectors are fixed on linear motion units. These units are linked to the CCPS-Control, so that during injection the needles do not move relatively to the stack.

After injection the consolidation of the adhesive is realised. The consolidation consists of compaction and curing. The compaction is done by rollers pressing onto the stack. Here again both surfaces of the L-shape have to be considered. Subsequently infrared heater elements accelerate the curing of the adhesive. Especially the steps Chemical Stitching, Compression and Heating are to be in a close relationship to ensure a sufficient degree of cure of the adhesive. Otherwise the stabilising behaviour of the adhesive is drastically reduced.

Finally after curing the preform is transferred through the drive and a mould fixing the shape. The preform can then be cut to the desired length and transported into the injection and curing mould.

Results

A high degree of innovation was accomplished by using semi-finished textiles without means of thermoplastic or thermoset powder binder. To stabilise the preforms thermoset stitching dots are injected by Chemical Stitching. This process diminishes the use of binder and therefore reduces material costs. Furthermore the stability of preforms becomes adjustable which gives additional opportunities in context of their formability and drapability. The development of this technology further advances the applicability of automated continuous processes for dry textiles. The ecological benefits of dry textile processes compared to prepreg processes are the lower energy usage during storage of the textiles and for curing the resin injected component. Automated preforming enables the reproducible production of near-net-shape textile preforms and thus simultaneously improves process stability and productivity.Continuous preforming processes can supply the number of preforms necessary for large scale mass production of composite components. More efficient processes will allow the introduction of composite into new areas, smaller aircraft, for example. This will in turn lead to a reduction in fuel consumption and emissions.

Within CleanSky the project will supply the preforms to be used in the EcoDesign for Airframes ITD. I will also introduce the production ready technology of continuous preforming developed by Broetje Automation to the members of the ITD. Furthermore it will demonstrate thefeasibility of the innovative Chemical Stitching technology, developed by Fraunhofer ICT, for minimally invasive preform stabilisation.

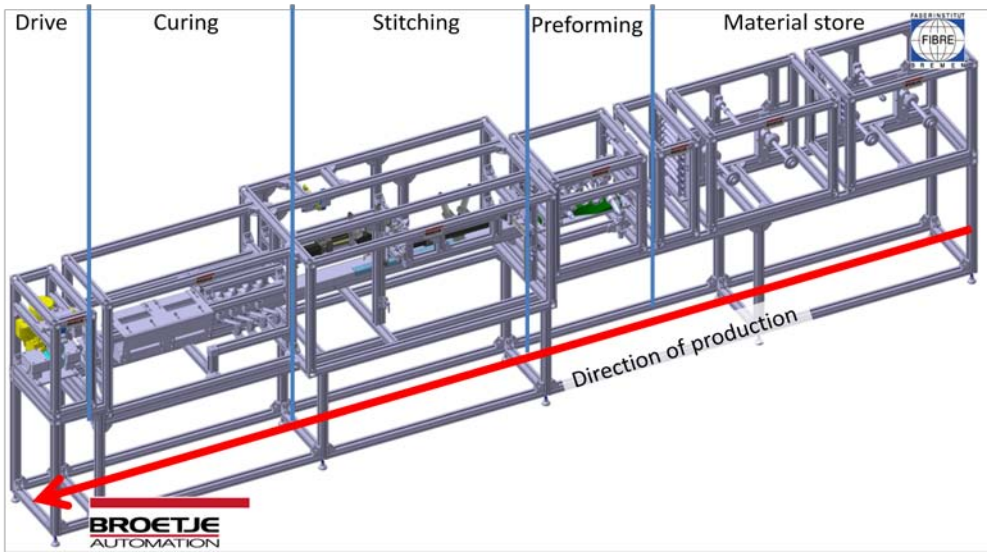

Figure 1Automated chemical stitching and preform production line

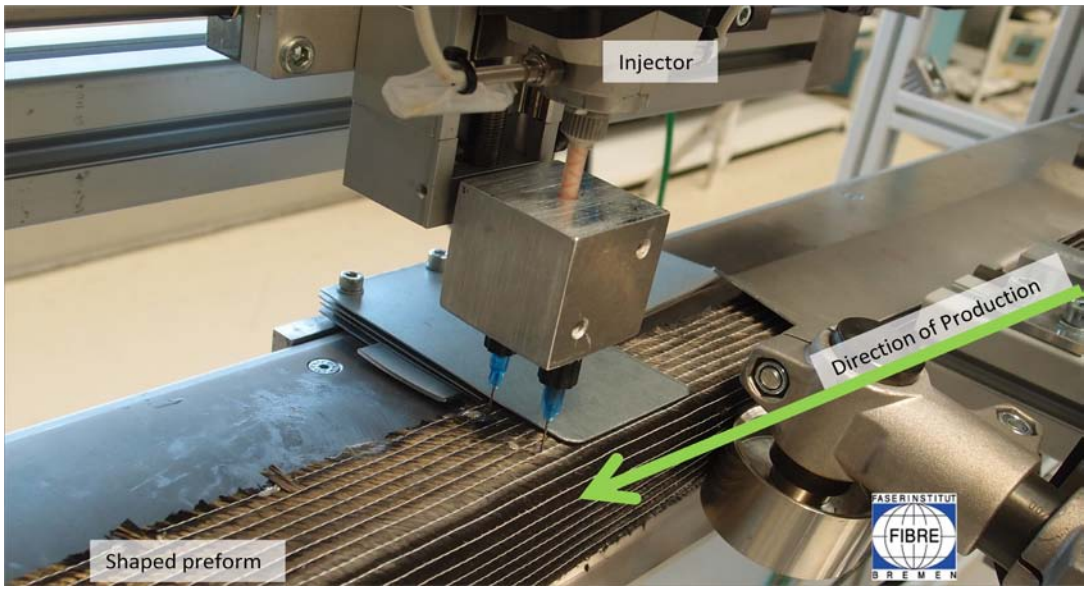

Figure 2 The chemical stitching injector assembly with the shaped and stitched preform in the foreground

Project Summary

Acronym :	AChSo
Name of proposal:	Automated Chemical Stitching and Preforming
Technical domain:	Airframe
Involved ITD	Eco design
Grant Agreement:	323485
Instrument:	Clean Sky
Total Cost:	300 000€
Clean Sky contribution:	220 000€
Call:	JTI-CS-2012-01-ECO-01-052
Starting date:	10/2012
Ending date:	3/2014
Duration:	18
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