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## Completion of the EC funded PreCarBi project for the simulation of Liquid Resin Infusion of New Composite Materials

### ESI GmbH successfully coordinates the project

The PreCarBi European Research Consortium, initiated by [ESI](#) three years ago, has involved eleven partners from nine countries, and had the main objective to develop a new generation of bindered composite materials and associated simulation tools, specifically dedicated to high performance applications in the Aerospace industry.

#### Background

Today, manufacturers of advanced composites use either layers of pre-impregnated plies (prepreg) to form a laminate, or resin infusion of dry textiles (Liquid Composite Molding or LCM). Generally, prepreg composites have superior stiffness, strength and fatigue resistance due to toughened resins and high fiber content, which are well dispersed in an organized fabric architecture. However, this type of materials suffers from high costs, limited shapeability, complex, expensive and time-consuming manufacturing, and limited shelf life. While LCM technologies can overcome these drawbacks, LCM relies on low viscosity resins for infusion and suffers from fiber misalignments due to textile patterns, both leading to poorer mechanical performance intolerable for many structural aircraft applications. This is why and where the PreCarBi project intervened to improve composite materials for LCM.

## Project objectives

The scientific aim of PreCarBi consortium was to develop new binder composite materials that allow pre-form designs to be manufactured and shaped under high temperature; or local tow reinforcement to be added under high temperature. This resulting research is considered an important contribution for advanced Liquid Resin Infusion (LRI) technologies to compete with expensive and complex pre-preg composite technologies.

[ESI GmbH](#) was coordinator of this consortium. In addition, [ESI](#)'s major contribution to the project was forming, infusion and mechanical analysis of industrial aerospace applications manufacturing with the LRI technology.

## Description of the work

The PreCarBi project took into account three principal materials:

- New composite materials for bindered carbon yarns, developed by Tenax, in an iterative process to achieve the required performance;
- Compatible resins, developed by Huntsman;
- Converted new binder yarn composites into industrial preforms (Woven or Non-crimp Fabric) produced by Sigmatech and Airbus Operations GmbH.
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Additional extensive materials characterization and testing work was performed by further research partners to assess and quantify improvements as the new materials were becoming available.

From these efforts, [ESI](#) was then able to adapt [PAM-QUIKFORM](#) and [PAM-RTM](#), simulation solutions for thermoforming and manufacturing of plastics and composites, to the industrial simulation of draping and LRI of binder yarn composites. Consequently, within the latter half of the project, industrial partners tested the new materials by applying them to selected industrial problems which are traditionally manufactured using only prepreg technologies. At this stage, a close collaboration between [ESI](#) and the industrial partners took place to help with numerical design and validate the industrial structures. Finally, the University of Patras worked on the development of cost analysis tools to help quantify the cost reductions over prepreg manufacturing.



Overall, the research consortium, coordinated by [ESI GmbH](#), included two aircraft manufacturers: Airbus and Eurocopter; a tier one supplier: FACC; three materials manufacturers: Toho Tenax Europe, Sigmatex and Huntsman Advanced Materials (Switzerland) GmbH; a digital simulation software supplier: ESI Group; and four universities and research institutes: Cranfield University, IPM Latvia, University of Patras and SICOMP.

Different draping and injection strategies were finally tested on three industrial demonstrator parts using the new materials and the LCM manufacturing feasibility analyzed during the research project.

*“Composites have become the material of choice for many advanced aircraft structural applications, but research is still required to identify more cost effective manufacturing and simulation tools to optimize their manufacturing and design”, said Dr. Anthony Pickett, Scientific Director at ESI GmbH. “The PreCarBi project has made a significant contribution to a new binder composite that will have a significant impact on the composite manufacturing industry and the aircraft manufacturing industry as a whole.”*

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*The PreCarBi Team*



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