

Induction Consolidation/Molding of Thermoplastic Composites Using Smart Susceptors

Efficient Processing of Lightweight Thermoplastic Composites

Today, hundreds of millions of pounds of composite components are processed each year using energy-inefficient processing methods. With many markets transitioning to lightweight composites for performance gains, the use of these components is rising rapidly. In this fast-growing sector, manufacturers have the opportunity to introduce new energy-efficient systems and materials that may yield large energy savings and improved recycling.

Induction consolidation/molding of thermoplastic composites using smart susceptors will significantly reduce energy use by eliminating the need to heat the tooling and surroundings, as is done in other conventional composite manufacturing methods, such as autoclave or oven processing. Thermoplastics do not require an extended cure at elevated temperatures and enable rapid component manufacturing cycles, as compared to thermoset materials. Thermoplastic resins can also be melted and consolidated repeatedly with minimal degradation, making them excellent candidates for recycling.

This project will assess the viability of induction consolidation of thermoplastic composites and accelerate the introduction of the process into the wind, aerospace and automotive markets.

Benefits for Our Industry and Our Nation

Induction consolidation/molding of thermoplastic composites using smart susceptors will significantly reduce the cycle time and energy used for manufacturing and will increase the performance of the resulting components. The characteristic rapid processing cycle of induction consolidation of thermoplastic composites not only saves energy, but may also significantly improve component affordability. In addition, integrating these lightweight components into aerospace and automotive vehicles will reduce the vehicles' fuel consumption and carbon emissions.



Induction molding press with seatback tool installed in the press at AjaxTOCCO, Madison Heights, MI.

Image courtesy of The Boeing Company.

Applications in Our Nation's Industry

The induction process offers significant benefits to the aerospace, automotive, and wind turbine manufacturing industries.

In its full implementation, this process could be used to make a significant number of composite components in both the aerospace and wind energy markets and make significant inroads into the market for automotive components that are currently made of steel or thermoset composite materials, accounting for approximately 10% of vehicle weight. This could result in millions of tons of components being produced each year using the induction consolidation process.

Project Description

The objective of this project is to explore and define the technical and economic viability of induction consolidation/molding of thermoplastic composites using smart susceptors as a sustainable manufacturing platform. Component and material evaluations are being made for aerospace, wind power, and automotive applications and results will be used as the basis for decisions to proceed to a pre-production scale development.

Barriers

- The cost of switching from thermoset materials to thermoplastic materials may be high for the aerospace industry
- Using thermoplastic materials in automotive components would require a significant change to manufacturers' material supply base and fabrication infrastructure. Design challenges remain, and further understanding is needed of the impact of switching structural components to composite, particularly concerning crashworthiness. Another major challenge is meeting the demanding production rates that characterize the automotive industry

Pathways

The project will move the induction consolidation/molding process from the development stage to the component testing stage.

The project will verify that substituting thermoplastic composite materials into the automotive, aerospace, and wind energy markets will result in the estimated energy savings. During this phase, the project will select candidate components for fabrication and testing.

Once the majority of the energy estimates and the design have been reviewed and approved, the team will begin tooling fabrication and modeling, with an emphasis on the simpler part tooling first. The tooling fabrication and testing will be serial in nature, so that knowledge from the first design can be folded into the next design. As the tools move through an initial tryout, they will be fine-tuned as required to provide the necessary capability.

The component material selection and material placement methods will be performed by the three market segment participants involved in the project (Boeing, Ford, and Vestas). Each of the three will have preferred resins based on cost and performance for their applications. These companies will work with Cytec and others to provide the best form of material to meet the goals of the program. The team will also develop the mechanism for material placement to create the parts identified as good candidates for the process.

Milestones

This project started in August 2008.

- Investigation of material characteristics for the development of product design guidelines (Completed)
- Completion of product service requirements, product designs, and validation testing

- Tooling design build and equipment design build (Two of three tooling sets and the induction press have been completed)
- Developing and expanding the capabilities and breadth of the induction consolidation process in 2012

Commercialization

The team will target entry-level components for initial commercialization. All project partners have extensive commercialization knowledge and experience in their own market segments. As a result, these companies will ensure that once the process is developed, there will be a supply base for equipment and tools so that the infrastructure is available to support supply needs. A very efficient path to implementation will be possible because the team is composed of market segment users and material, equipment and tooling suppliers.

Project Partners

The Boeing Company
Seattle, WA
Principal Investigator: Marc R. Matsen
E-mail: marc.r.matsen@boeing.com

Ford Motor Company
Dearborn, MI

Cytec Engineered Materials
Anaheim, CA

Steeplechase Tool & Die Inc.
Lakeview, MI

Temper, Inc.
Rockford, MI

Vestas Wind Systems
Portland, OR

Ajax TOCCO
Warren, OH

For additional information, please contact

Stephen Sikirica
Technology Manager
U.S. Department of Energy
Industrial Technologies Program
Phone: (202) 586-5041
E-mail: stephen.sikirica@ee.doe.gov