

Transition

An example of Air Force supported SBIR/STTR technology that has been transitioned into an Air Force or other DoD system or subsystem or used by Air Force test ranges and facilities or maintenance depots.

SBIR Topic Number:
AF04-137

SBIR Title:
Reusable Internal
Mandrels for
Composites Repair
or Fabrication

Contract Number:
FA8650-05-C-5300

SBIR Company Name:
Cornerstone Research
Group, Inc., Dayton, OH

Technical Project Office:
AFRL Materials &
Manufacturing
Directorate, Wright-
Patterson AFB, OH



Left: Following composite cure, the Smart Mandrels tool is heated above its activation temperature. The material softens and then can be easily extracted. Right: SMP Bladders are the sole tooling system used for fabrication of an eight-foot unmanned aerial vehicle (UAV) fuselage for a prime defense contractor. (Photos: CRG copyrights 2007 and 2010).

Reusable Shape Memory Polymer (SMP) Mandrels

- The Air Force needs innovative tooling solutions that will significantly speed the process and reduce the costs of design, fabrication, assembly, production, and extraction of male mandrels from cured composite components
- Cornerstone Research Group, Inc. (CRG) developed and optimized shape memory polymer (SMP) mandrel materials and processes for rapid fabrication of complex and trapped geometry composites, including high-temperature materials for aerospace applications
- CRG currently has contracts with several commercial companies, including a prime defense contractor, and CRG's Smart Tooling is also the sole tooling system used in production of an eight-foot fuselage in an unmanned aerial vehicle (UAV) application
- For CRG's customers, the Smart Tooling product line averages more than 75% cost savings over conventional tooling systems

Commercialization Pilot
Program Series

RX2010-037

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Air Force Requirement

Conventional tooling systems for fabrication of complex and trapped geometry composites can be very costly and time consuming to design, fabricate, and extract from a cured composite such as ducting. Removal of a mandrel is often a tedious, puzzle-like process and exposes the cured part to handling damage, tool drop, and other fabrication-related damages.

The Air Force needs innovative tooling solutions that will significantly speed the process and reduce the costs of design, fabrication, assembly, production, and extraction of male mandrels from cured composite components.

SBIR Technology

Cornerstone Research Group, Inc. (CRG) developed and optimized shape memory polymer (SMP) mandrel materials and processes for rapid fabrication of complex and trapped geometry composites, including high-temperature materials for aerospace applications. The SMP mandrel process, Smart Tooling, incorporates SMP material into two innovative tooling product lines: Smart Mandrels™ and SMP Bladders.



Shape memory polymer-based tooling offers benefits in materials and labor costs (Photo: CRG SMP copyright 2007)

Smart Mandrels are targeted at applications requiring a rigid mandrel during cure, while SMP Bladders are for applications requiring an inflatable bladder during cure for composite consolidation. Both product lines offer significant benefits in both materials cost and labor associated with fabrication of complex geometry composites.

The thermally activated SMP tooling system can function both as a rigid mandrel during cure (Smart Mandrels) or as elastomeric bladders (SMP Bladders). The mandrels are

delivered to the customer in a blank configuration, usually a cylinder, and then heated in a clamshell tool and formed using internal air pressure. When the tools are cooled, they are temporarily locked into the formed configuration. After the composite is cured, the tools are heated and transition into their elastomeric state and return to the blank shape for easy extraction. The tools are then ready to be reformed for the next composite lay-up.

Under the SBIR project, the mandrel process was optimized and tolerance/repeatability testing was performed. The Smart Tooling process resulted in significantly reduced labor time, lowered material cost, and reduced waste.

Transition Impact

CRG currently has contracts with several commercial companies, including a prime defense contractor. CRG's Smart Tooling is also the sole tooling system used in the production of an eight-foot fuselage in an unmanned aerial vehicle (UAV) application. For CRG's customers, the Smart Tooling product line averages more than 75% cost savings over conventional tooling systems.

Company Impact

This SBIR project allowed CRG to generate subsequent funding for both additional product development and production from commercial customers and the US Air Force and Navy. CRG's product line is now trademarked and is spinning off into a business called Smart Tooling, which will feature Smart Mandrels and SMP Bladders products. The result of this project is the commercialization of cost-effective, time-saving composite tooling solutions in multiple industries.

CRG conducts research and development, from molecule to manufacturing, in an array of markets. The company's core competencies are systems design, non-metallic materials, and manufacturing process development.



SBIR/STTR

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