National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Manufacturing

# Fabrication of Fiber-Metal Laminates with Non-Autoclave Processes

VARTM-based technique enables larger, less expensive hybrid laminate parts

NASAs Langley Research Center developed a new technique that enables the preparation of metal/composite hybrid laminates, also known as fiber-metal laminates (FML), through a one-step processing method. Currently FMLs are prepared by a compression process using a press or autoclave with metallic layers sandwiched between layers of glass or graphite prepreg (preimpregnated fibers with a matrix resin). NASAs process essentially eliminates the need to produce prepreg prior to the production of a hybrid laminate. It also allows the production of large, net shape structures that were previously not possible with autoclave or press technologies due to size constraints. This infiltration and infusion process can be accomplished using pressure (resin transfer molding [RTM]), or a vacuum induced pressure differential (vacuum assisted resin transfer molding [VARTM]).

## BENEFITS

- Part sizes can be larger than those possible from autoclave or press processing
- Eliminates the need for complex tooling (as needed in autoclave or press processing) and thus is less expensive
- Produces high quality, low void content hybrid laminates with high fiber volumes without need for previously prepared prepreg
- Requires no autoclaves or presses
- Can be used to produce curved laminate structures and complex shapes

## APPLICATIONS

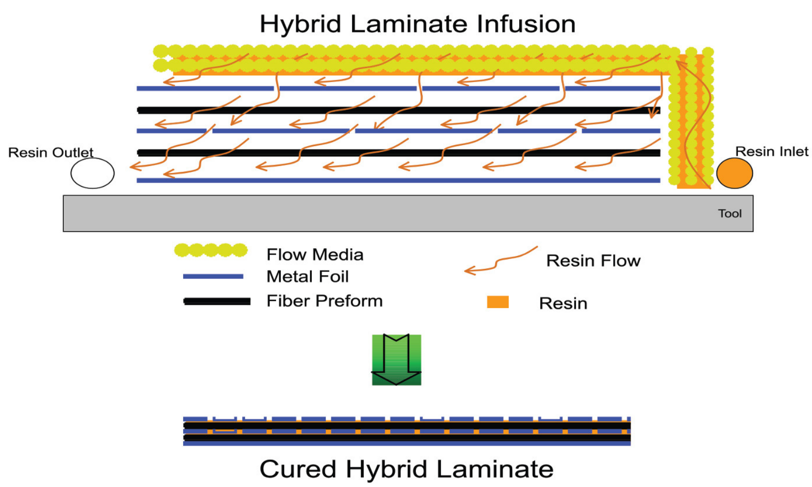
The technology has several potential applications:

- The technology offers wide-ranging market applications, including:
- Aeronautics and aerospace structures - e.g., fuselage, floors, liners, cargo containers
- Pressure vessels and storage tanks
- Automotive structures
- Ballistic protection - explosives, bomb containment

## THE TECHNOLOGY

The FMLs resulting from the NASA process have similar properties to traditionally produced metal/composite hybrid laminates including, as compared to either the composite or metal only structures, improved load carrying capability, lighter weight, improved stiffness, improved impact resistance and damage tolerance, and improved permeation resistance. The NASA process can be applied to various FML types, including GLARE (glass, aluminum, epoxy), and TIGR (titanium, graphite). Typical manufacturing processes are costly and complex shapes are hard to produce, whereby the NASA process enables use of these kinds of laminates without an autoclave or press, thus increasing the size that can be produced and decreasing the cost.

The resin pathways in the foils enable connection between the plies that can improve the interlaminar strength of the final part. Functionally the NASA process creates resin columns in the transverse direction of the plies. NASA is working to optimize the final properties by varying the size and distribution of the pathways.




Schematic of the hybrid metal foil laminate infiltration process where resin flows both in-plane through the fabric layers and transversely through the flow pathways of the metal foils

Hybrid metal foil laminate fabricated by a VARTM process showing the relative size of flow pathways in the metal foils. Resin flow pathways shown are approximately 0.016 inches in diameter.

## PUBLICATIONS

Patent No: 7,595,112

**technology.nasa.gov**

## More Information

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**Agency Licensing Concierge**

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