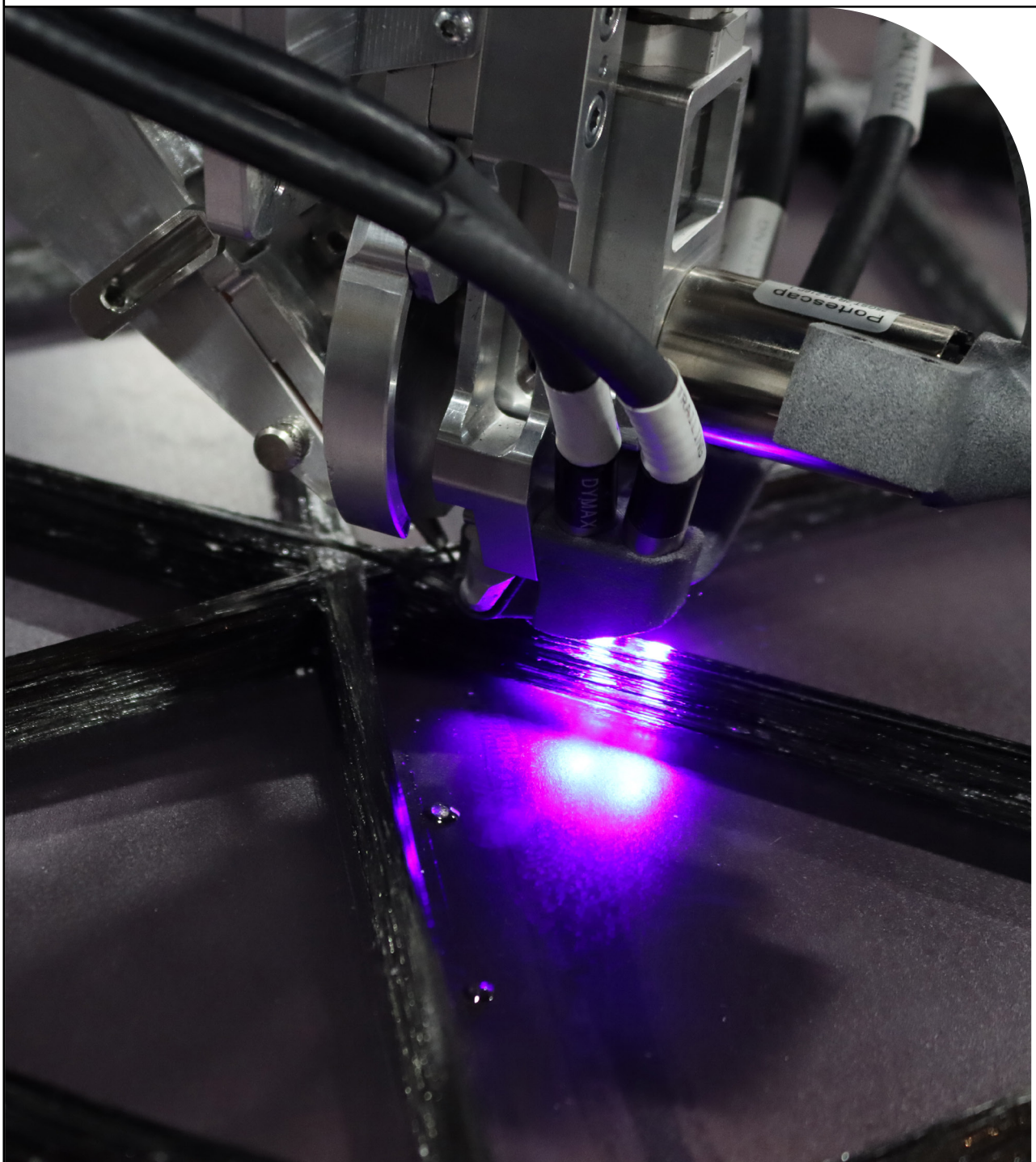
ARKEMA

Case study

Efficient manufacturing of lightweight composite designs enabled by PolyMat™ - High Tg



SUMMARY

PARTNER
Continuous Composites
www.continuouscomposites.com

INDUSTRY
Composites: aerospace, defense, unmanned aerospace

APPLICATION
High-performance continuous fiber engineered components for aerospace structures

PRINTING TECHNOLOGY
Continuous Composites' CF3D® technology

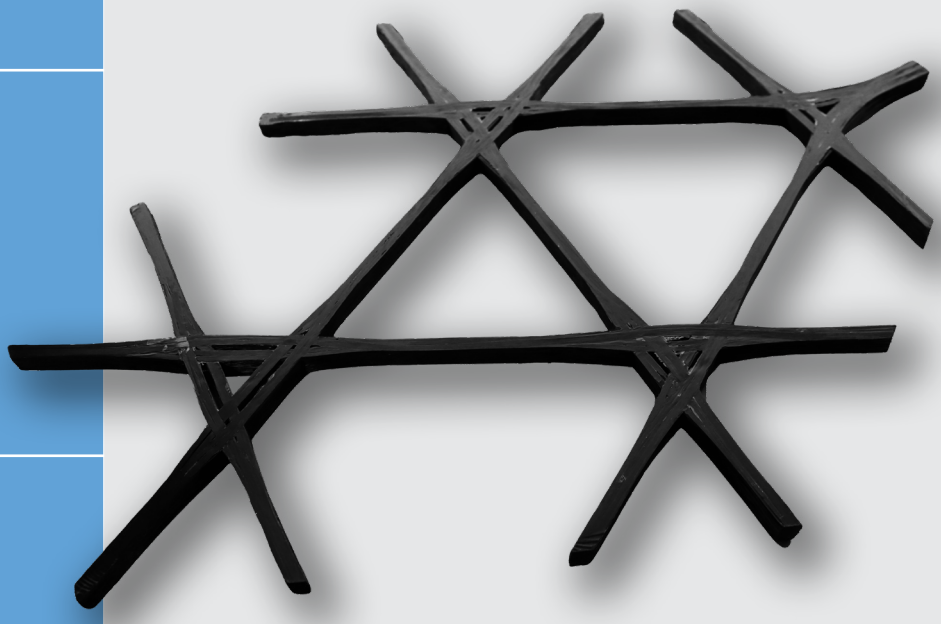
MATERIAL
N3xtDimension® photocurable resins

CASE STUDY

INTRODUCTION

Arkema and Continuous Composites have committed to disrupting the industry by codeveloping an original, fully formulated material, PolyMat™ - High Tg, to produce lightweight, high-temperature-resistant structures.

Continuous Composites' patented continuous fiber 3D printing technology (CF3D®) presented a fundamental shift in composites manufacturing. CF3D® can combine high-performing composite materials with rapid-curing thermoset resins to create complex parts on demand. With the ability to print both carbon and glass fibers, Continuous Composites has designed a new future for additive manufacturing with composites. Through the partnership with a leading materials innovator such as Arkema, the teams work together to design the next generation of materials to meet customer applications and industry challenges.



Developing PolyMat™ - High Tg product

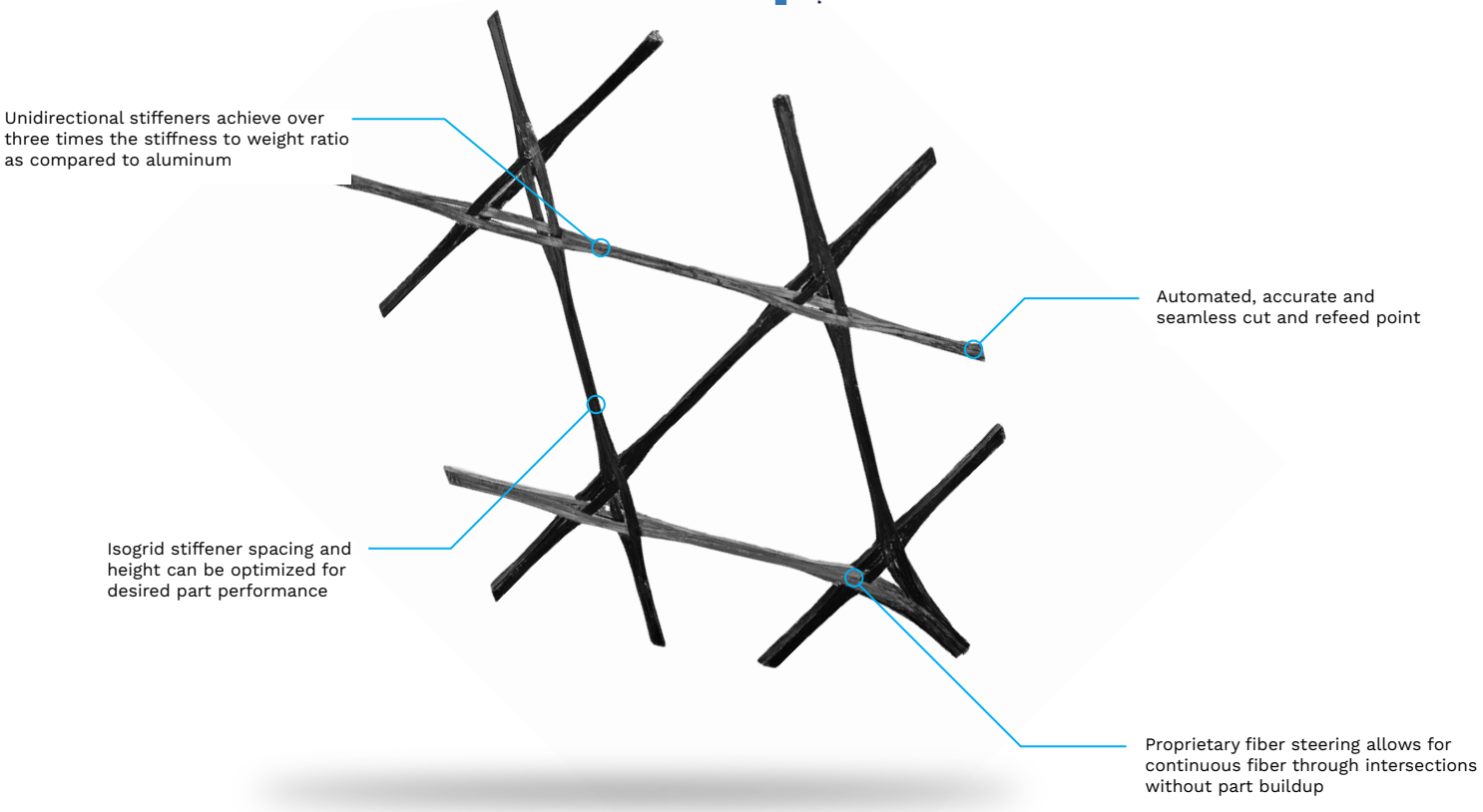
CHALLENGE

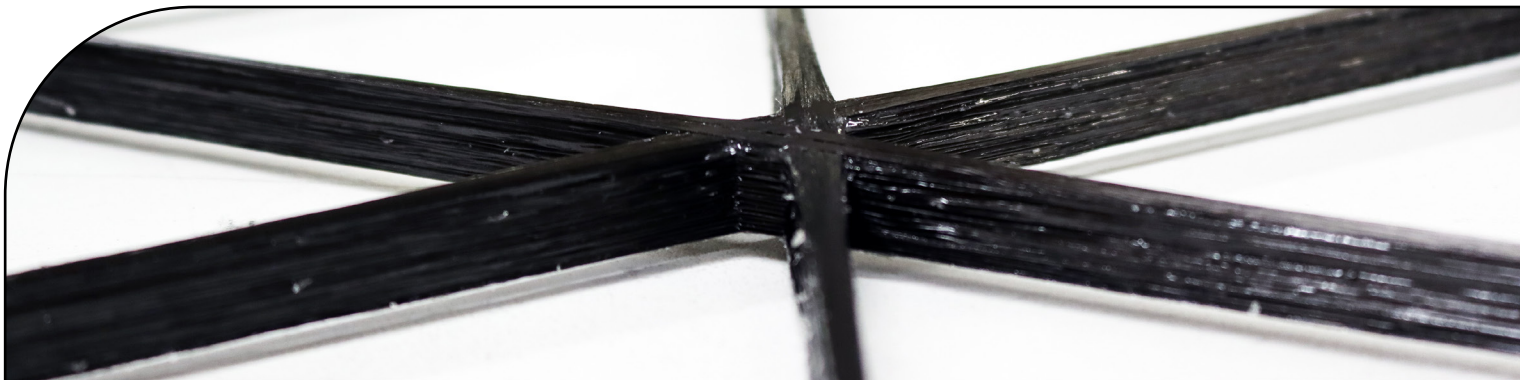
The challenge to develop photopolymer materials for CF3D® technology demanded a stronger, faster and smarter solution to keep up with the disruptive and industrial nature of CF3D. Additive manufacturing (AM) of large-area steered fiber composites requires resins that are both printable and versatile to meet high-performance demands for a variety of applications. The introduction of AM technologies has disrupted traditional design and manufacturing processes for a variety of material systems such as metals, polymers, ceramics, and composites.

To capitalize on the benefits afforded by CF3D® AM technology, a new family of strong, photocurable resins was required. Continuous Composites knew that Arkema was the right partner to take on the challenge to develop N3xtDimension® novel material solutions to meet the needs of advanced AM composite printing.

The teams set out to develop a resin system that was capable of:

1. Instant green/tack strength
2. High interlaminar adhesion
3. Fiber wetting
4. Dimensional consistency throughout cure





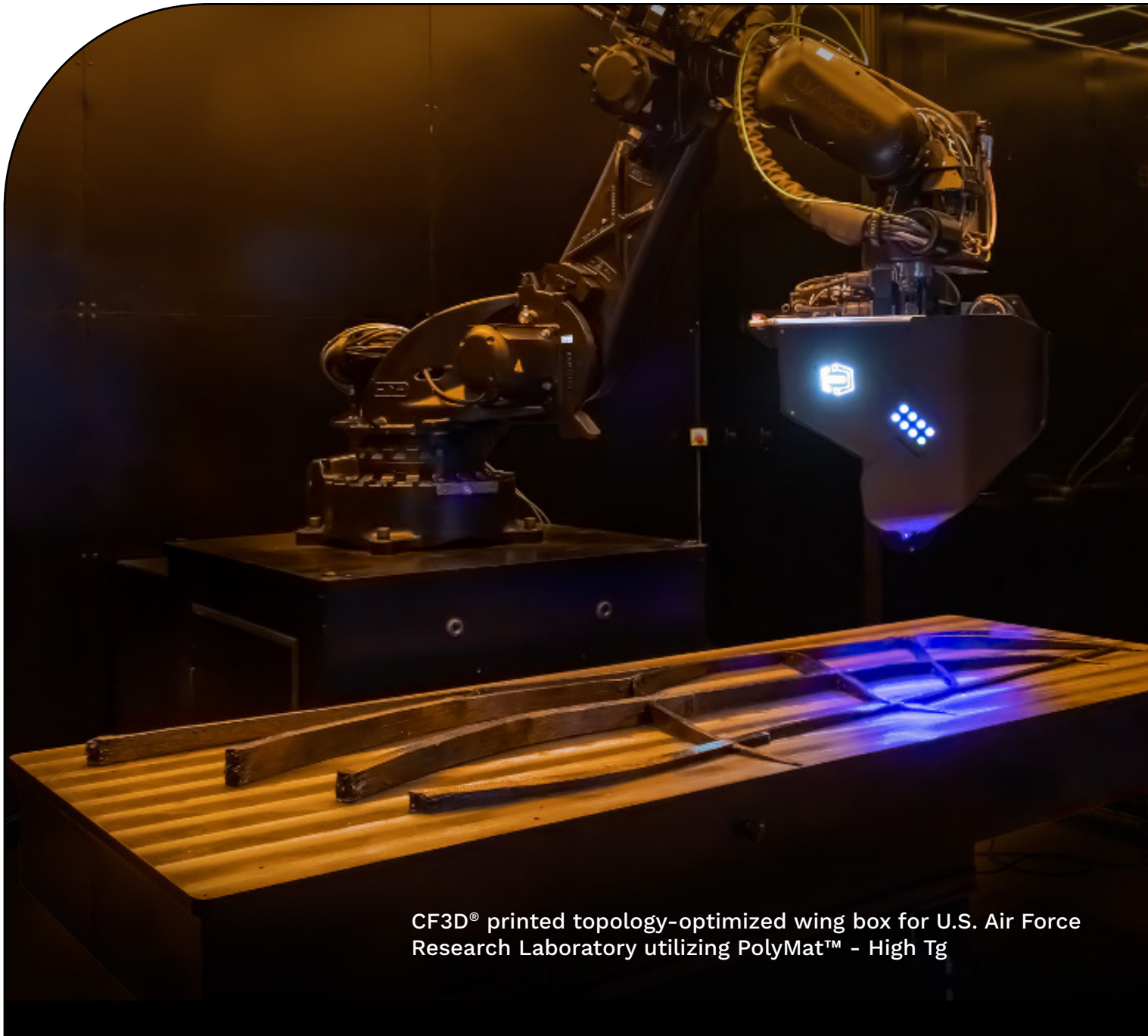
SOLUTION

Through the joint R&D efforts, a new and exclusive material was born: **PolyMat™ - High Tg** for printing of continuous carbon and glass fibers to produce lightweight, high-temperature-resistant structures. This innovation met rigorous application and performance testing before being launched at Formnext in 2022.

Enabling topology-optimized prints

The use of topology optimization (TO) in design and manufacturing has greatly benefited from maturing AM technologies. The ability to print with single-fiber tows that are wetted and cured in situ using PolyMat™ - High Tg resin from Arkema's N3xtDimension® line of resins allows CF3D® technology to produce parts that are not possible to make using incumbent processes. Dynamically steered and snap-cured fibers unlock the manufacturing of more organic shapes and unique geometries derived from TO designs with continuous fiber.

An example can be seen in the image below of CF3D® and PolyMat™ - High Tg printing a 9 foot (2.7 meter) continuous fiber drone wing for the Air Force Research Lab.



CF3D® printed topology-optimized wing box for U.S. Air Force Research Laboratory utilizing PolyMat™ - High Tg

Material performance

Our PolyMat™ - High Tg solution delivers the most advanced materials solution to accelerate composites manufacturing across industries, with credibility by large players in the composite industry. Presenting up to 50%+ fiber volume fractions (FVF), homogenous in-situ impregnation, less than 2% void content, and heat tolerance up to 227°C, PolyMat™ - High Tg allows for the printing of continuous carbon fiber and glass fibers.

1. High speed (>125 mm/s)
2. High FVF (> 50%)
3. Less than 2% void
4. High Tg (227°C)
5. Good fiber wetting

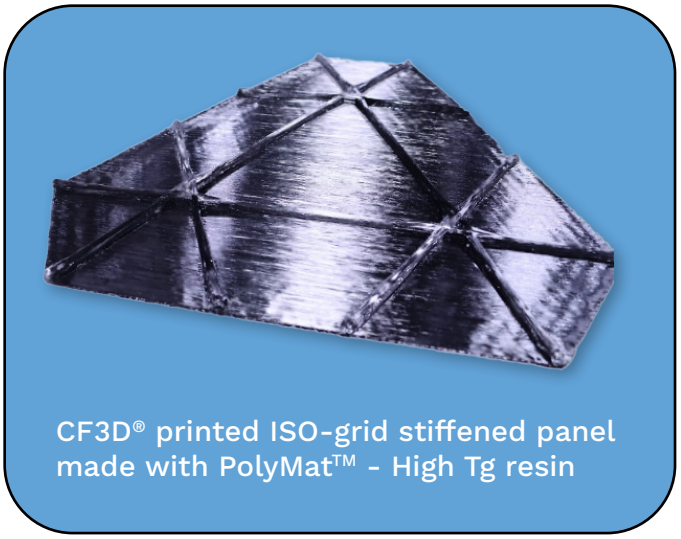
Packaging

In order to integrate PolyMat™ - High Tg into the CF3D® printhead for use, a new packaging solution was developed by the Arkema and Continuous Composites engineers. Utilizing a rigid plastic 0.55 liter bottle with a threaded cap, the resin is shelf stable for 12 months following manufacturing and is ready to use by threading it into the CF3D® printer.

Continued developments

The work between Arkema and Continuous Composites to revolutionize 3D printing and composites does not stop here. With new applications and material demands, the teams are ready to work together for continuous improvement of their industrial solutions.

One example of the continued efforts is the recent introduction of CeraMat™ Carbon/Carbon resin for the creation of Carbon Bonded Carbon precursor parts for ultra-high temperature applications.



CF3D® printed ISO-grid stiffened panel made with PolyMat™ - High Tg resin

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