Thermoplastic PAEK based Solutions for Aerospace and Urban Air Mobility Applications

Gilles Larroque

Global Strategic Marketing Manager - Aerospace

Victrex

ACMA
American Composites Manufacturers Association

Objective / agenda

The objective of this presentation is to introduce how thermoplastic composites-based solutions can address eVTOL challenges with a focus on weight & cost reduction and mass production.

Agenda:

- Victrex introduction
- Case studies for aerospace (and automotive industries)
- VICTREX AE™ 250 LMPAEK processing benefits
- Urban Air mobility potential applications
- Conclusion

1 – VICTREX introduction

2 – Case studies Aero and Auto

3 – VICTREX AE™250 LMPAEK processing benefits for Urban Air mobility potential applications

4 – Conclusion

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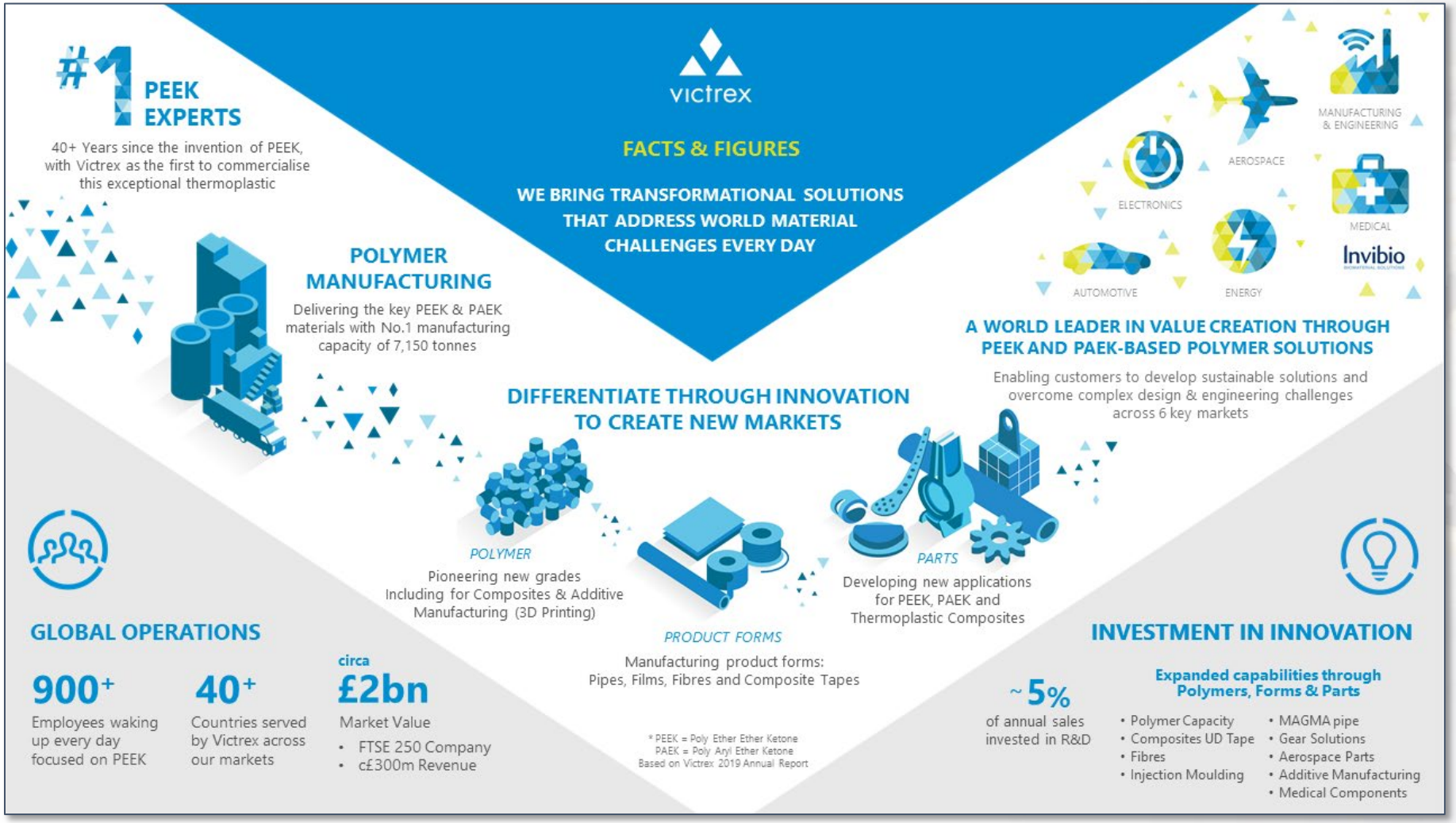
Victrex overview



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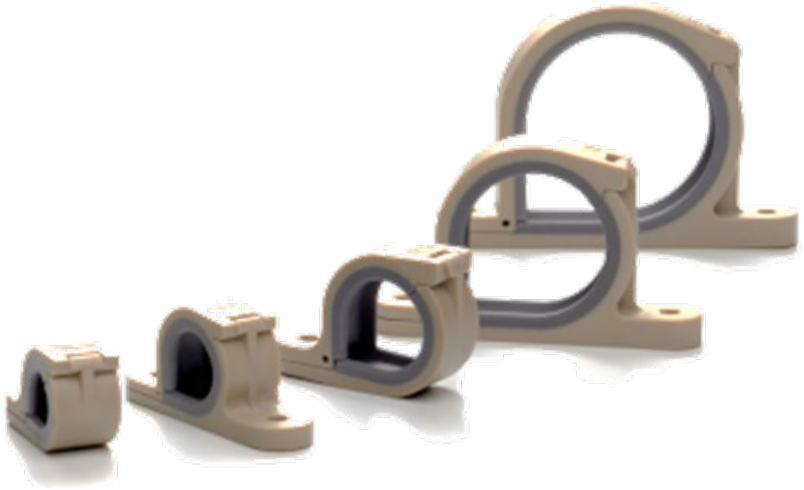
Unloaded brackets – wire bundle clamps



Amphenol Pcd

PERFORMANCE OUTCOMES

One customer realized:

20% **Weight Reduction** v. Metal

30% **Faster Installation** vs. Metal

- Injection molded PEEK for high volume production
- Introduced on the 787 & translated to 737
- Corrosion resistance for longer life, lower maintenance
- Lightweight, ergonomic, & durable design

Loaded bracket – aircraft door guide

AIRBUS HELICOPTERS

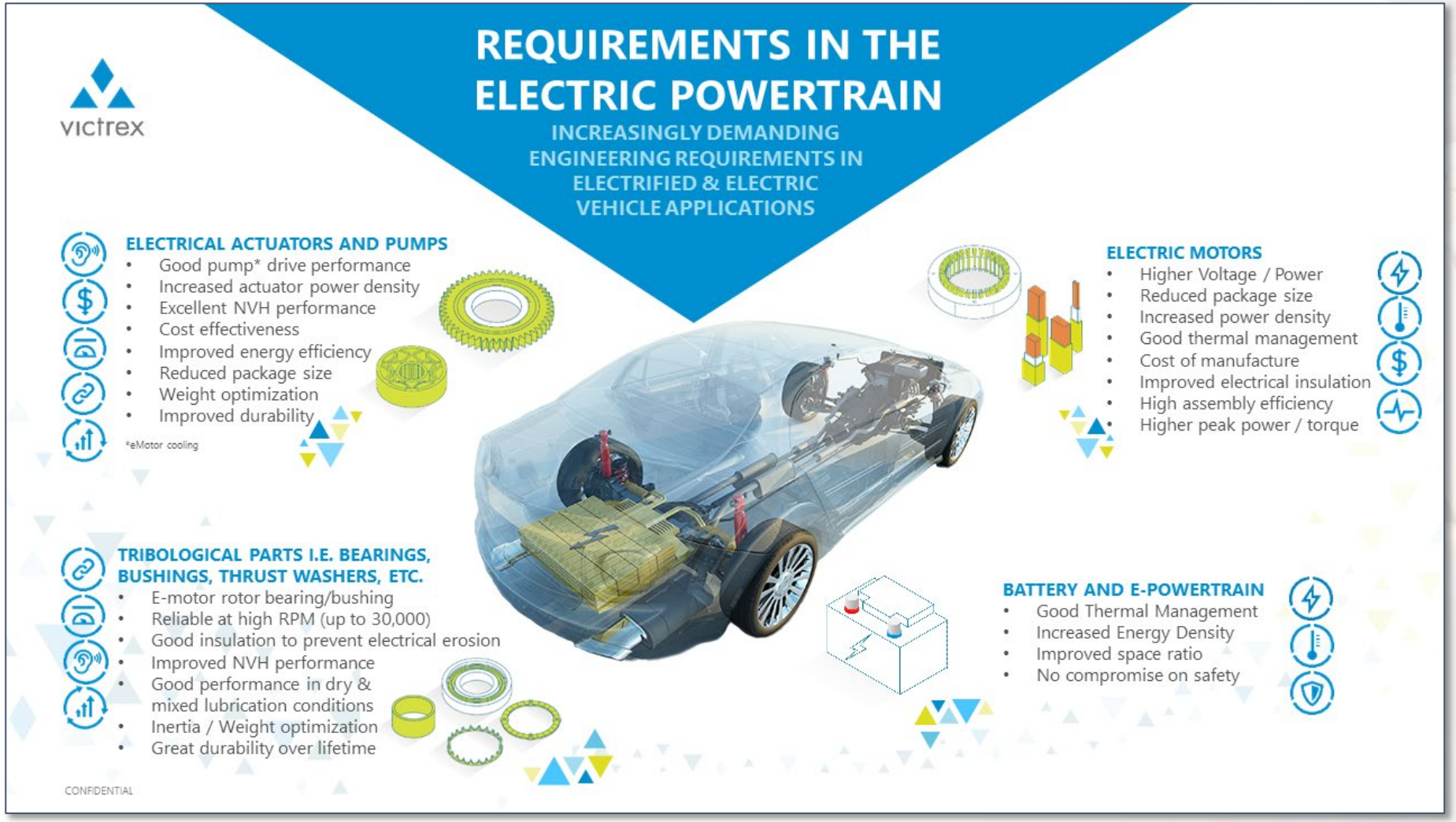
PERFORMANCE OUTCOMES

Up to **40%** **Weight Reduction** v. Aluminum

Up to **40%** **Cost Reduction** vs. Aluminum

- Targeted metal replacement to reduce cost and weight
- First structural component to be made of PEEK
- Eliminated secondary processing step previously required to prevent corrosion

Electric powertrain



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VICTREX AE™ 250 LMPAEK

Standard VICTREX PEEK –
Semi-Crystalline Thermoplastic Polymer
Typical application are injection molding, compression moulding and extrusion

- T_m= PEEK 343 °C
- T_g = PEEK 143 °C
- Crystallinity typically 25-30%

Victrex AE™ 250 PAEK continuous fibre tape
Lower melt PAEK resin matrix

- T_m= 303 °C
- T_g = 147 °C
- Crystallinity typically 25-30%

PEEK properties with a lower melting temperature”

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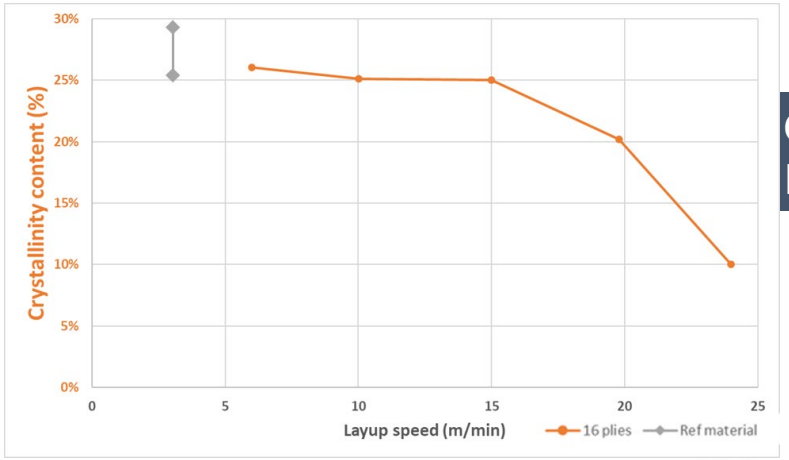
In-situ consolidation

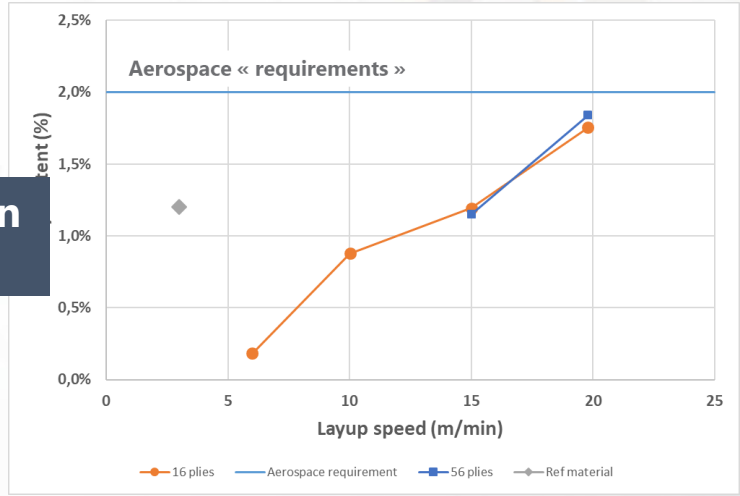
SETTINGS

Speed (m/min)	Number of Plies	Lay up temp (°C)	Tool temp (°C)
6	16	420	165
10			
15			
20			
24			
15	56	420	165
20			

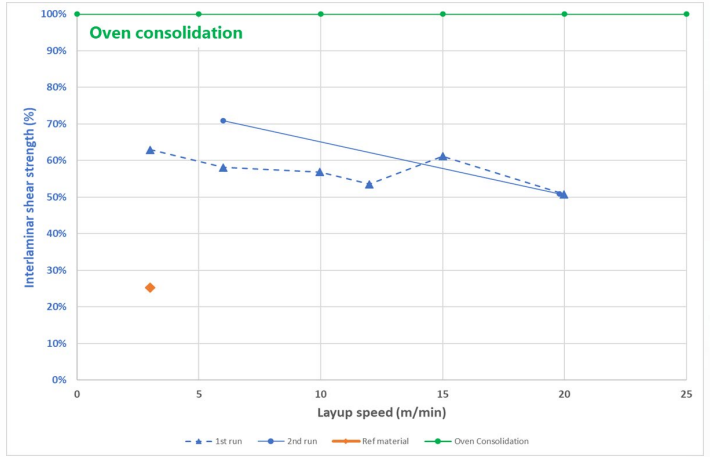
RESULTS



Crystallinity 20-25% up to 20m/min
Reference material : 25-30% at 3m/min



Porosity : Less than 2% up to 20 m/min
Reference material : 1,2% at 3m/min

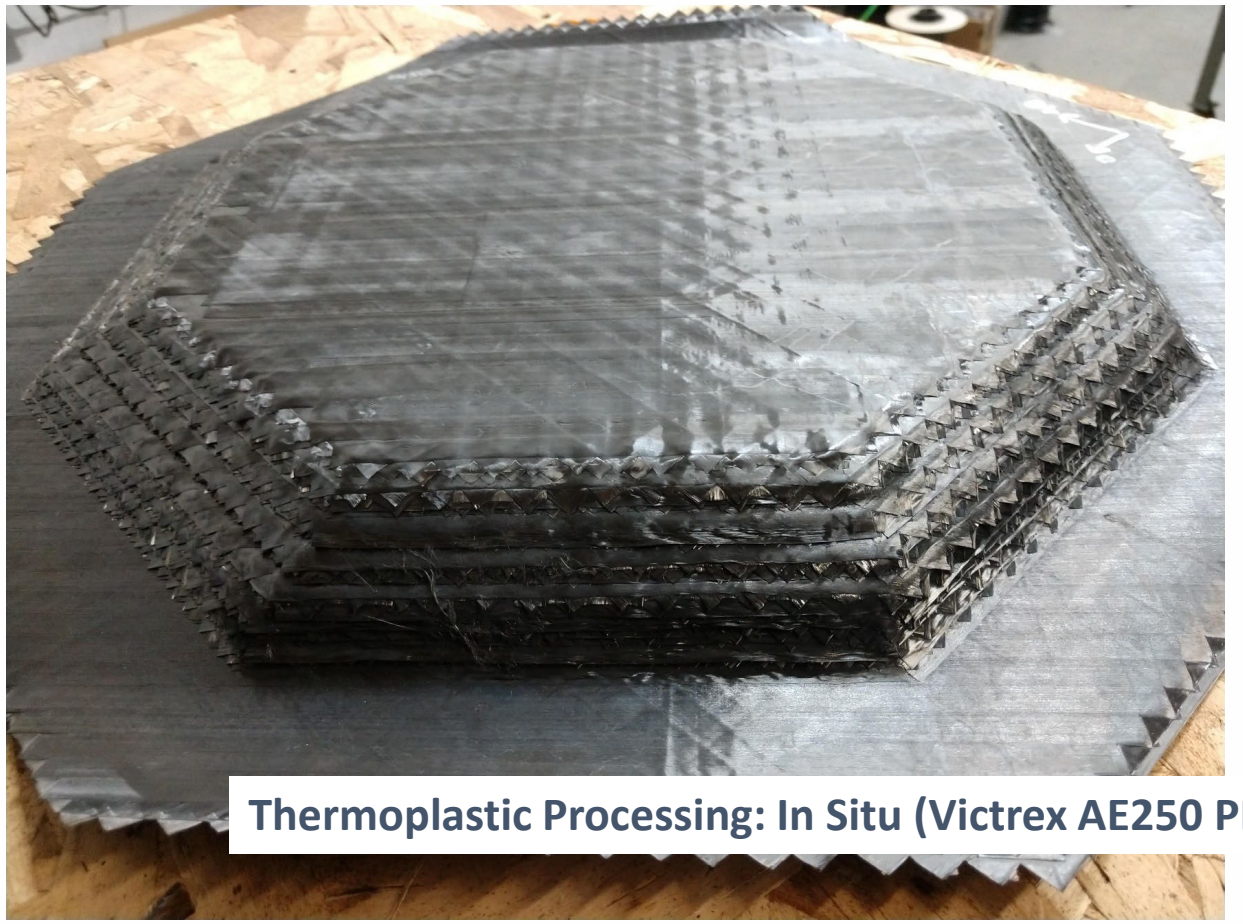


ILSS = 70% at 6m/min – 50% at 20m/min
Reference material = 25% at 3 m/min

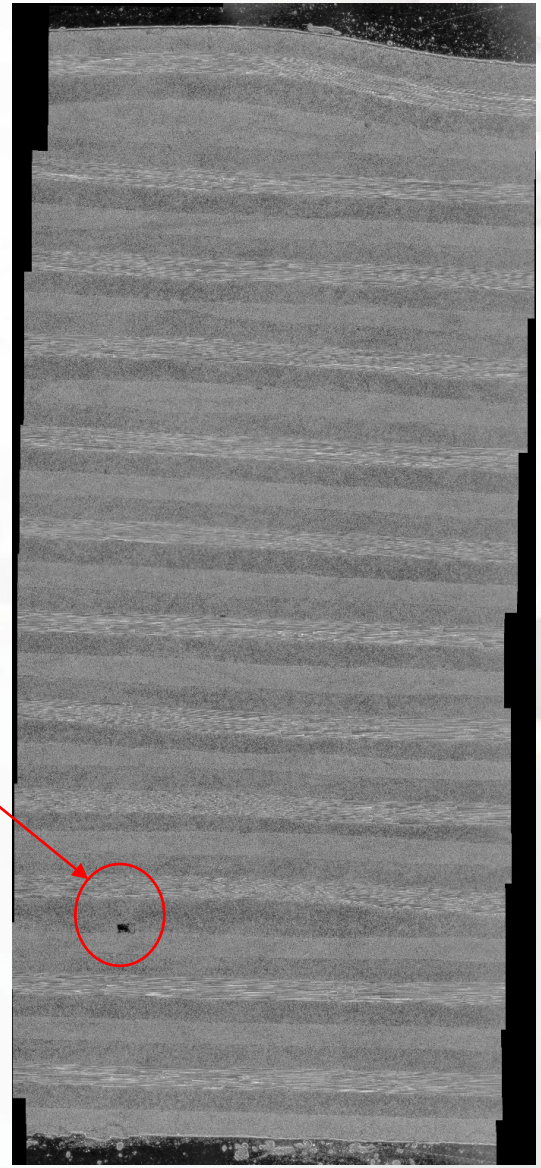
Reference material = another PAEK
UDT intended for a similar application

VICTREX AE™250 LMPAEK UDT

WORK WITH ELECTROIMPACT : IN-SITU



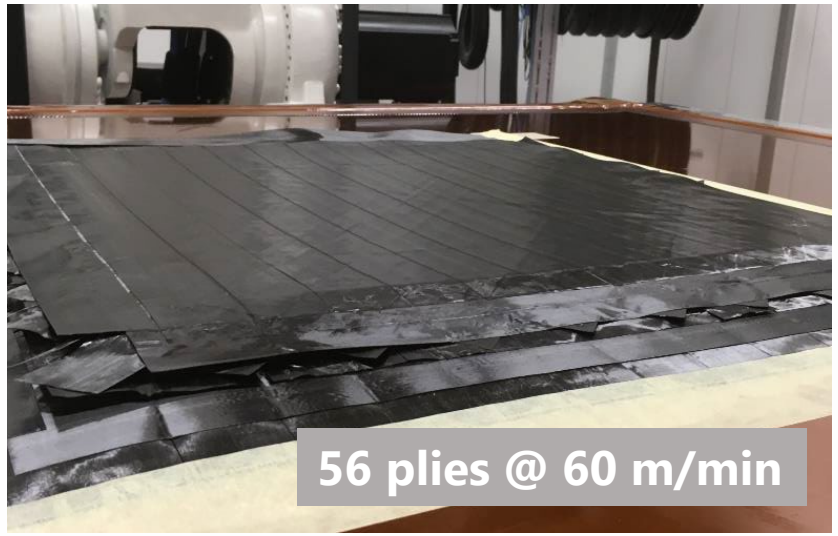
Thermoplastic Processing: In Situ (Victrex AE250 PEEK) 142P



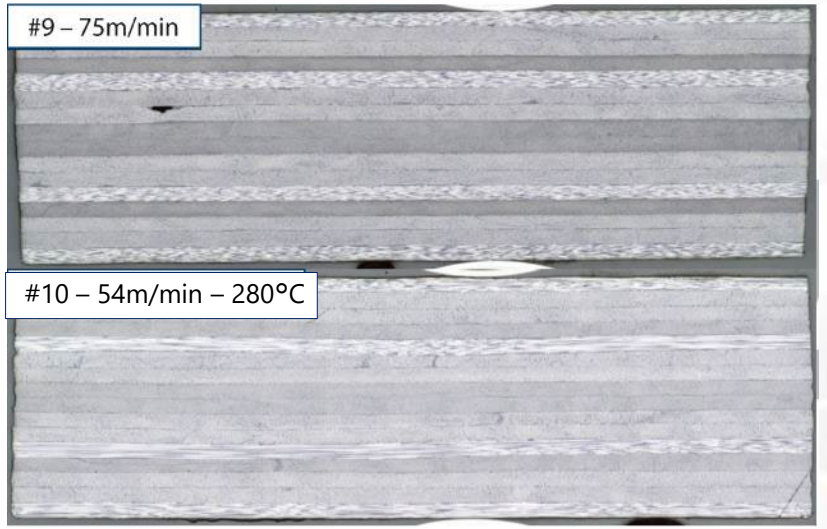
OOA/oven consolidation

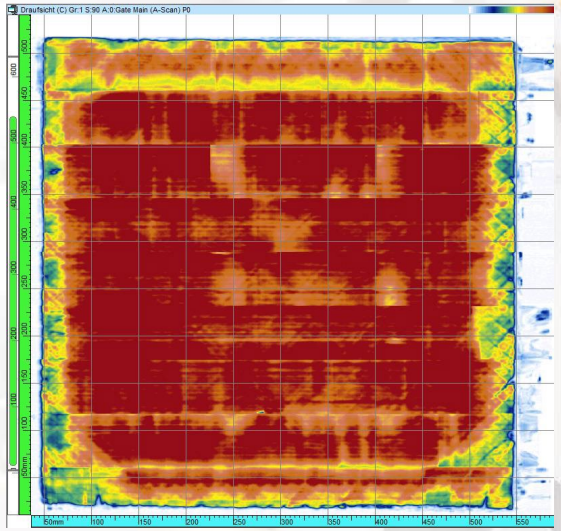
SETTINGS

Speed (m/min)	Number of Plies	Lay up temp (°C)	Tool temp (°C)
75	16	350	RT
54		280	
60	56	350	RT



RESULTS





29% crystallinity and ~0% porosity for both high speed and low temp panels

Both panel made with same number of plies

Highest speed achieved at 75m/min

Panel successfully made with a low lay up temperature at a speed of 54 m/min

Good level of porosity rate (close to 0%)

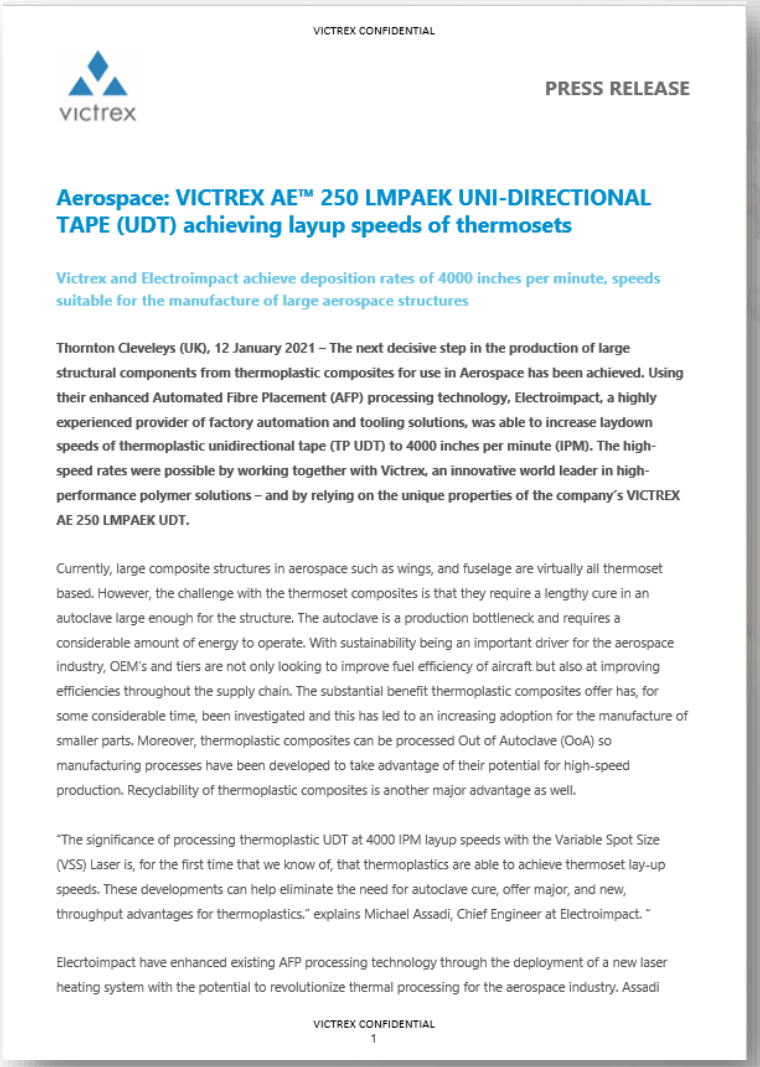
Good crystallinity level (29%)

VICTREX AE™250 LMPAEK UDT

WORK WITH ELECTROIMPACT

4000 IPM (=100m/min) layup speeds
achieved with VICTREX AE 250 LMPAEK
with Electroimpact AFP machine

Announced January 12th, 2021
https://www.victrex.com/news/2021/01/lmpaek-afp-layup



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victrex

PRESS RELEASE

Aerospace: VICTREX AE™ 250 LMPAEK UNI-DIRECTIONAL TAPE (UDT) achieving layup speeds of thermosets

Victrex and Electroimpact achieve deposition rates of 4000 inches per minute, speeds suitable for the manufacture of large aerospace structures

Thornton Cleveleys (UK), 12 January 2021 – The next decisive step in the production of large structural components from thermoplastic composites for use in Aerospace has been achieved. Using their enhanced Automated Fibre Placement (AFP) processing technology, Electroimpact, a highly experienced provider of factory automation and tooling solutions, was able to increase laydown speeds of thermoplastic unidirectional tape (TP UDT) to 4000 inches per minute (IPM). The high-speed rates were possible by working together with Victrex, an innovative world leader in high-performance polymer solutions – and by relying on the unique properties of the company's VICTREX AE 250 LMPAEK UDT.

Currently, large composite structures in aerospace such as wings, and fuselage are virtually all thermoset based. However, the challenge with the thermoset composites is that they require a lengthy cure in an autoclave large enough for the structure. The autoclave is a production bottleneck and requires a considerable amount of energy to operate. With sustainability being an important driver for the aerospace industry, OEM's and tiers are not only looking to improve fuel efficiency of aircraft but also at improving efficiencies throughout the supply chain. The substantial benefit thermoplastic composites offer has, for some considerable time, been investigated and this has led to an increasing adoption for the manufacture of smaller parts. Moreover, thermoplastic composites can be processed Out of Autoclave (OoA) so manufacturing processes have been developed to take advantage of their potential for high-speed production. Recyclability of thermoplastic composites is another major advantage as well.

"The significance of processing thermoplastic UDT at 4000 IPM layup speeds with the Variable Spot Size (VSS) Laser is, for the first time that we know of, that thermoplastics are able to achieve thermoset lay-up speeds. These developments can help eliminate the need for autoclave cure, offer major, and new, throughput advantages for thermoplastics." explains Michael Assadi, Chief Engineer at Electroimpact. "

Elecrtoimpact have enhanced existing AFP processing technology through the deployment of a new laser heating system with the potential to revolutionize thermal processing for the aerospace industry. Assadi

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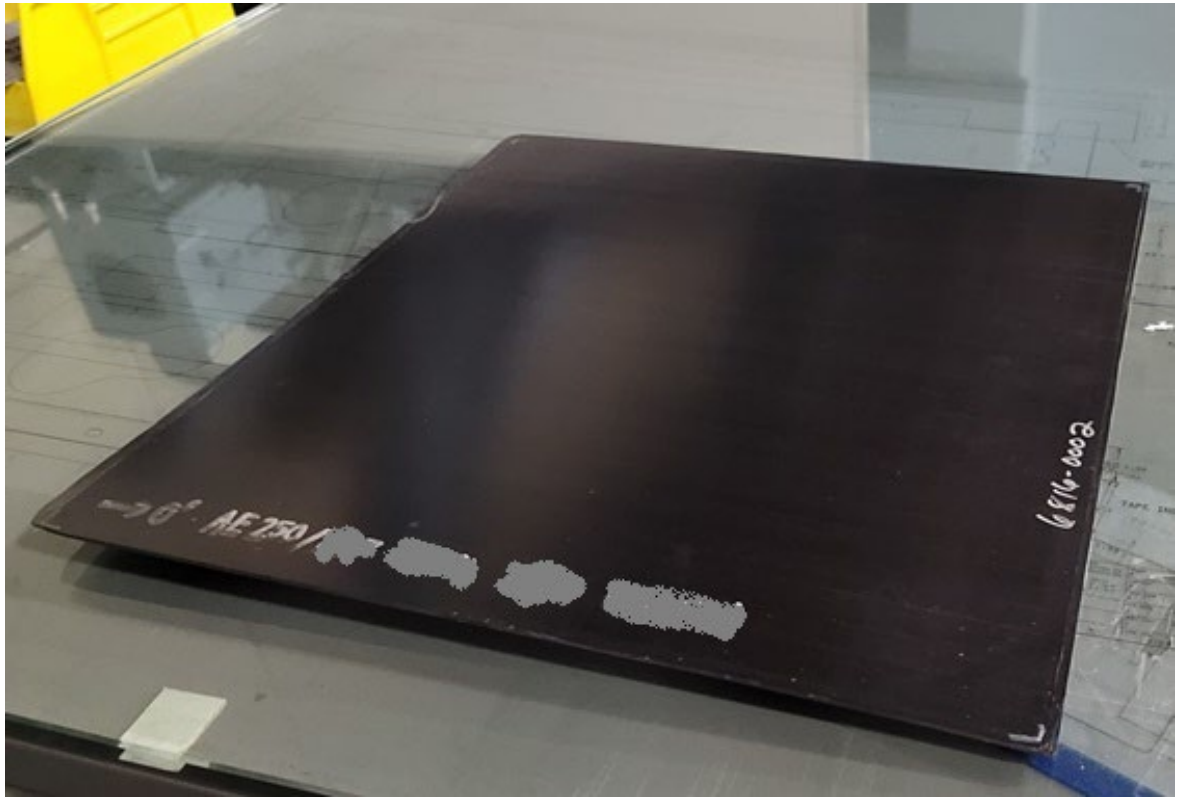
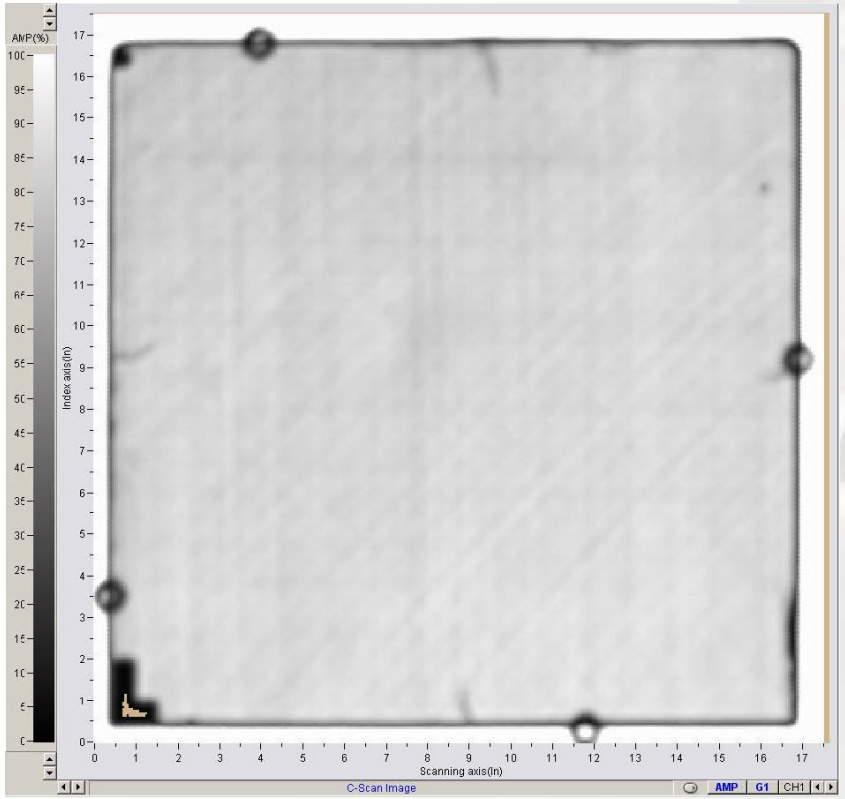
VICTREX AE™250 AFP processing

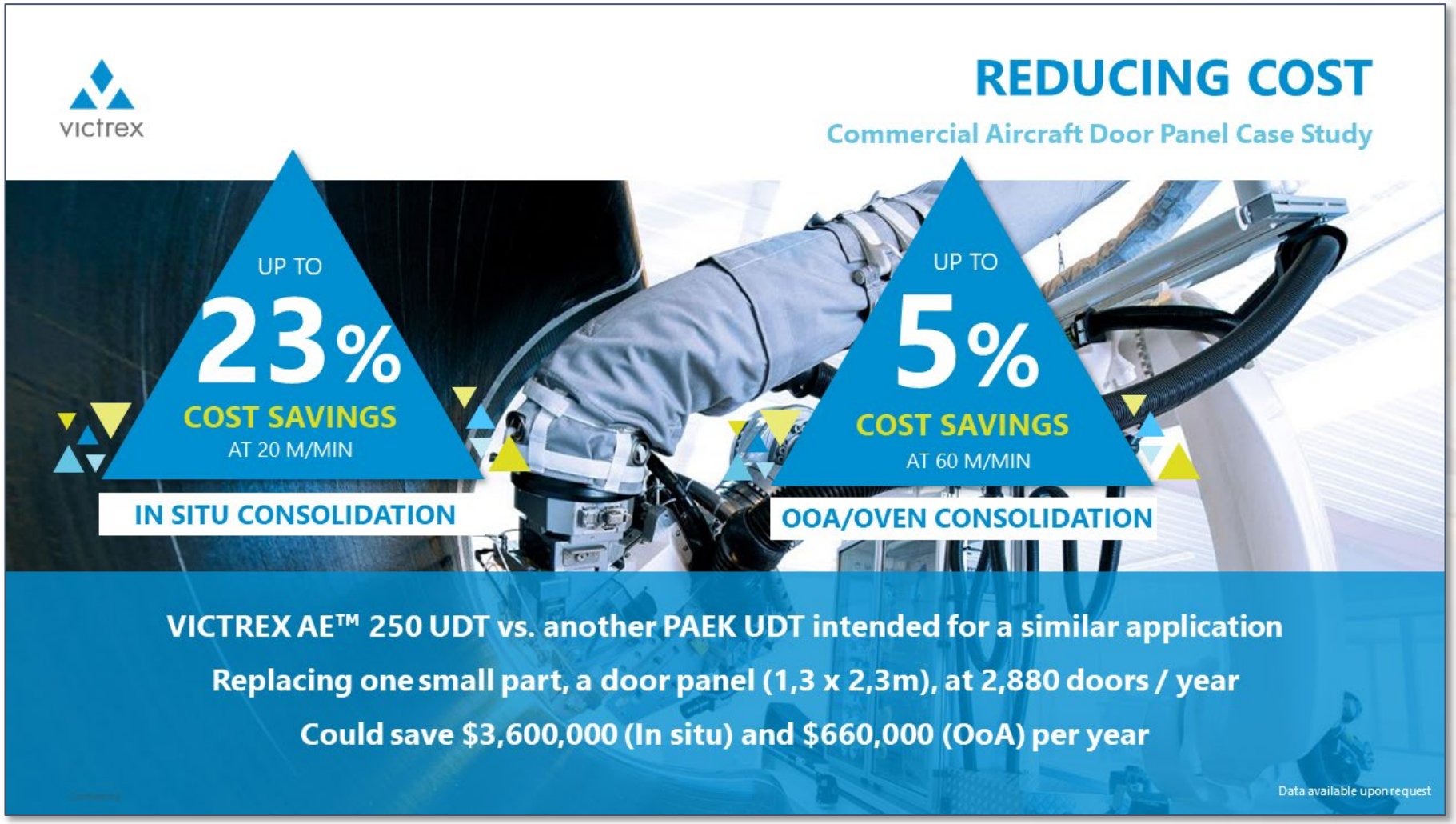
- no inclusions or porosity after press consolidation



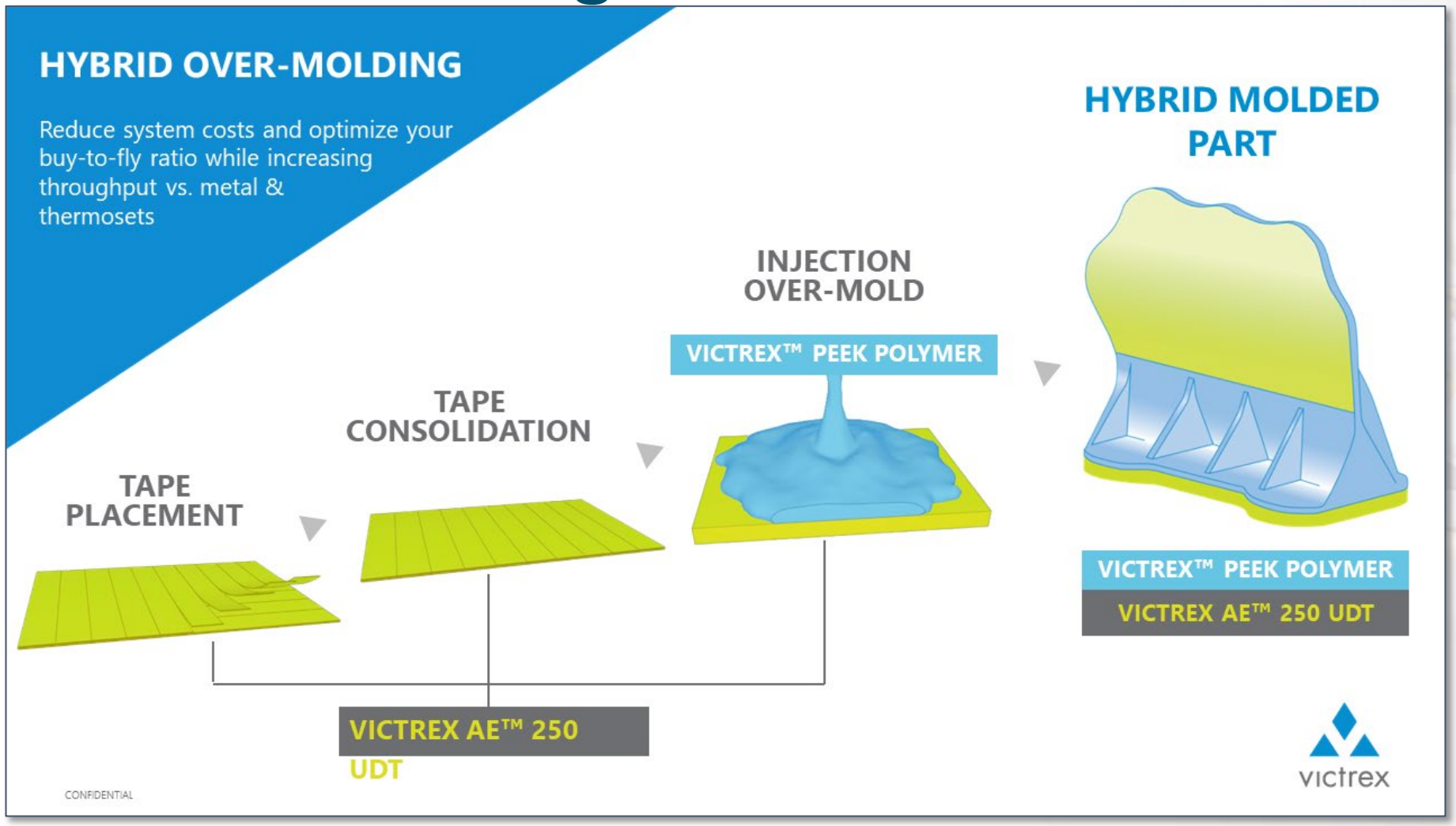


Increasing throughput

Reducing cost



Hybrid over-molding



Case Study – Aircraft OEM

VALUE

REDUCED WEIGHT, FASTER THROUGHPUT AND LESS WASTE

VICTREX AE™ 250 OVER-MOLDING SOLUTIONS REALIZED AIRCRAFT OEM:

- **58%** weight savings versus aluminum
- **43%** cost savings versus aluminum
- **6.8x** better Buy-to-Fly ratio versus aluminum

VICTREX AE™250 hybrid over-molding solution helps Aircraft OEM reduce recurring costs by improving manufacturing efficiency resulting in **€350,300 saved per year**

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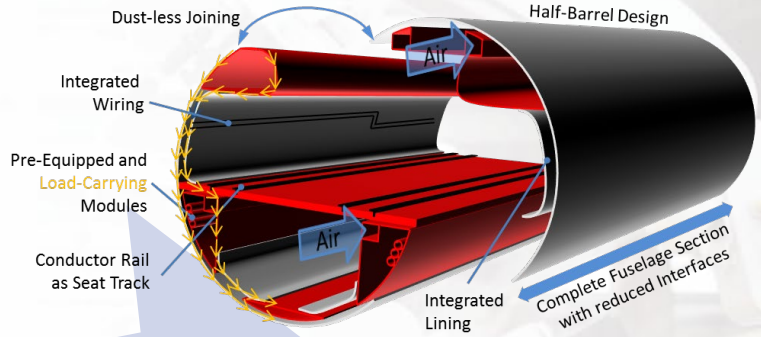
Design & certification expertise



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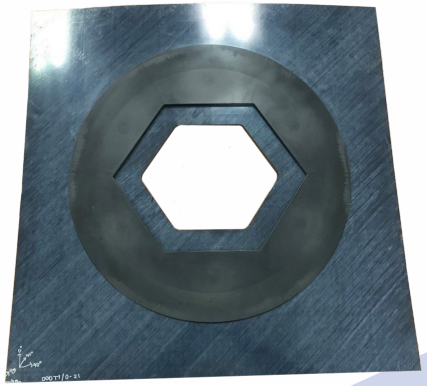

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Holistic design

Material performance e.g. Black Aluminum

Size & Complexity

Stamped Composite Loaded Brackets

Injection-Molded Loaded Brackets

Stamped Composite Highly Loaded Brackets

Assembly : welding, integrated solutions

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NIAR/NCAMP

3/10/2020 | 1 MINUTE READ

THERMOPLASTICS | MATERIALS | RESINS | FABRICS/PREFORMS | REINFORCEMENTS

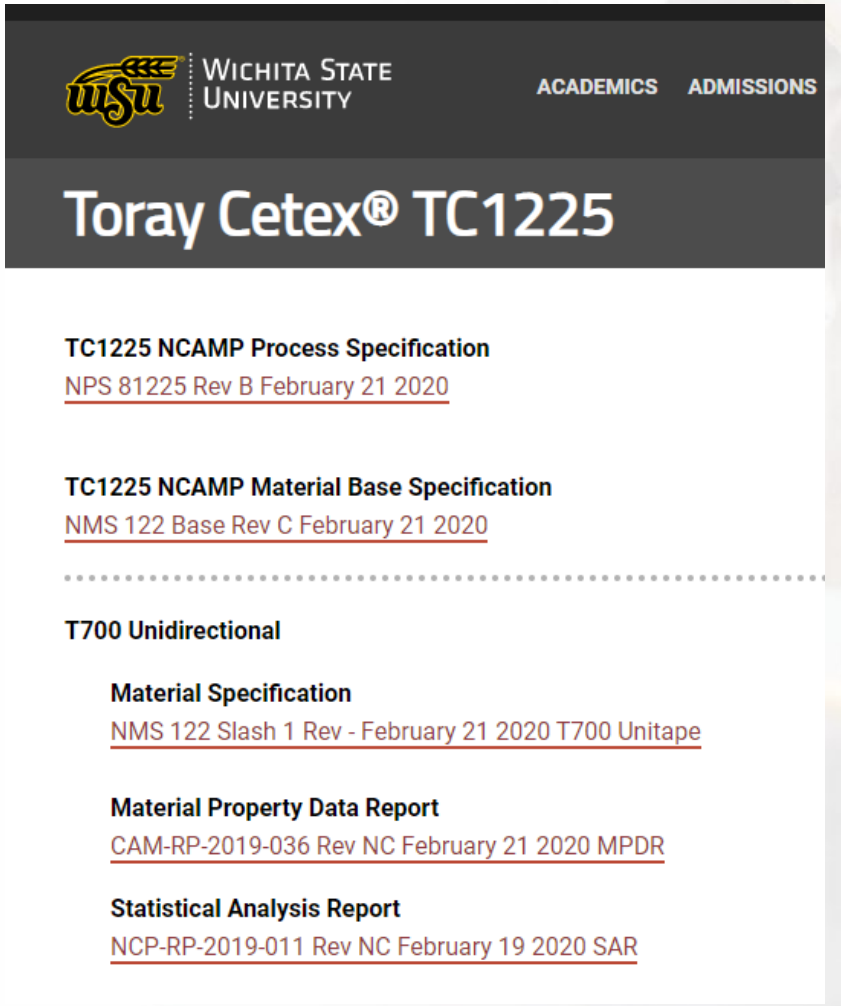
NIAR's NCAMP announces release of first thermoplastic material

Toray's Cetex TC1225 is a low-melt PAEK and is part of a broad effort by the National Center for Advanced Materials Performance (NCAMP) to qualify thermoplastic materials

#paek

Toray TC1225 NCAMP allowable availble under :

https://www.wichita.edu/research/NIAR/Research/torray-tc1225.php



Potential applications

Structural

Battery Boxes

Access Panels

Rotors

Cowls

Interiors

Seats

Bracketry

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COST REDUCTION

Thermoset vs. Thermoplastic Composites

(PROCESSING) COST $

THERMOSET COMPOSITES

Pre-Production

Storage/ refrigeration

Physical limitations of autoclave ***vs in-situ***
(part size/footprint/ infrastructure)

During Production

OoA
up to
30%
cost savings*

In situ
approximately
50%
cost**

+ no consumable cost
(bagging etc...)

+ Cost efficiencies from faster production speed

Post Production

Recyclable

TPC

+ Eco friendly
(solvent-free working environment)

+ Enables hybrid moulding

+ Bonding
(welding/fusing)

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eVTOL market / Victrex

Victrex Value Proposition

Lightweight Solutions
Short Development Cycle
Potential Cost saving
Short Part Manufacturing Cycle Times
Production Scaleup Time
Automated Mass Production

50%
(3 dB) Reduction in NVH

UP TO
58%
WEIGHT SAVINGS
VS ALUMINUM

UP TO
43%
COST SAVINGS
VS ALUMINUM

UP TO
60
m/min
Up to 2.5x FASTER
TAPE PLACEMENT SPEED

UP TO
20%
REDUCTION
IN CYCLE TIME FOR OOA CONSOLIDATION

UP TO
23%
COST SAVINGS
AT 20 M/MIN

FIT ?

Voice of eVTOL market

Problem to solve?

Reduce Urban Traffic jam
& travelling time
Reduce transportation cost

Why VICTREX PEEK™ ?

Light weight
Cost reduction
Speed up manuf. process
Mech. & Temp. resistance

Where?

Fuselage skin, primary & secondary structure
Battery isolation
Cooling system, Gears

How does it resonate with you? Let's get started on your next design!

Contact information

Gilles Larroque

Victrex – Aerospace Business Unit

Global Strategic Marketing Manager

glarroque@victrex.com

+33 (7) 86.77.34.96

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