



Water Soluble Mandrels

for Hollow Structures

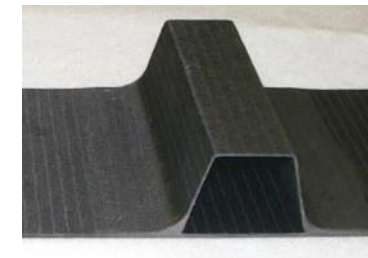
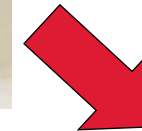
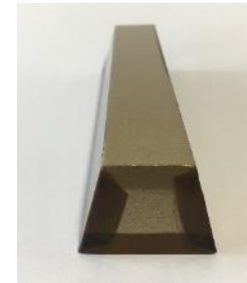
Dr. Jens Kärger
Head of Technology and Quality

Aero Consultants



About

- Hollow parts with closed shape require mandrel technology
- Existing mandrel or bladder techniques show disadvantages
- Aqua mandrels => New class of lost core
- Water soluble & Environmentally friendly
- Easy processing, safety & environmental advantages
- Applications:
 - Air- and Cable Ducts
 - Stiffening Structures
 - Pressure Vessels





Highlight Features

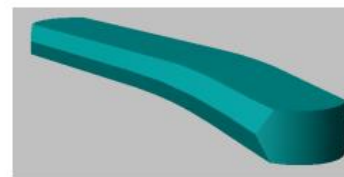
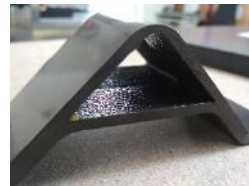
- Water soluble
- Lightweight 0.54 gcm-3
- Low CTE 5-5.6 E-6 K-1
- Temperature resistant 195°C
- Pressure resistant 8.5 bar
- Autoclave and RTM
- Compatible with common processes
- Smooth surface
- Automated manufacturing, machinable
- Fast wash-out
- Environmentally friendly – no wastewater treatment





Materials

- Aquacore™ wet paste
- Aquapour™ powder, castable
- Aquafill™ filler for repair
- Aqua Tool Bond water soluble adhesive mainly for blocks
- Aquaseal™ water soluble sealant
- Fastcore AquaCore for automated processing
- Cavuscore blocks, mandrels for high temperature & high pressure applications



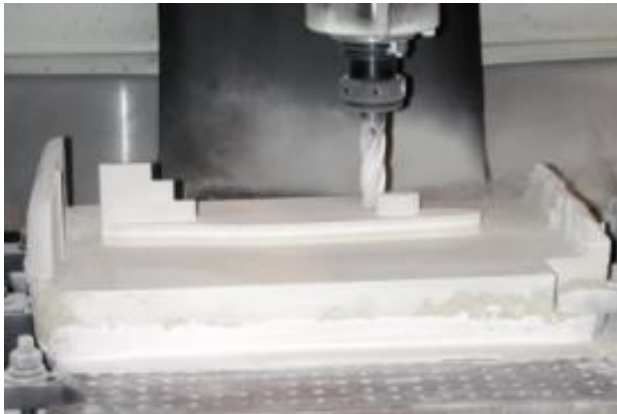
AQUA
MANDREL



Products

AquaBlock for Prototyping

- Pressed & Sealed
- Machinable



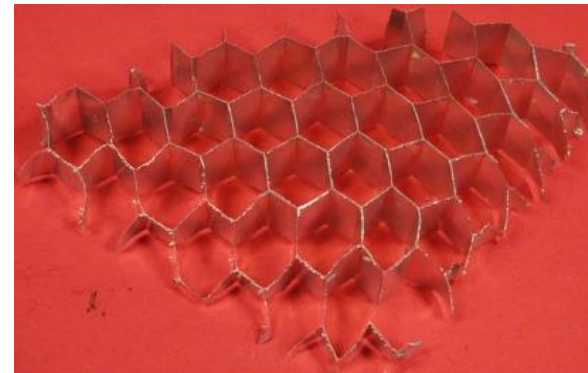
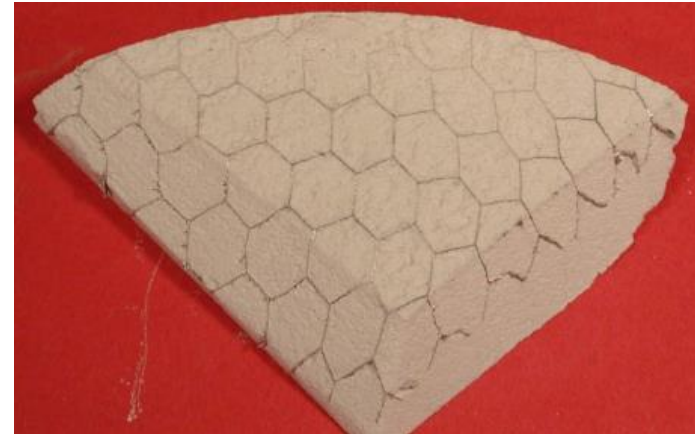
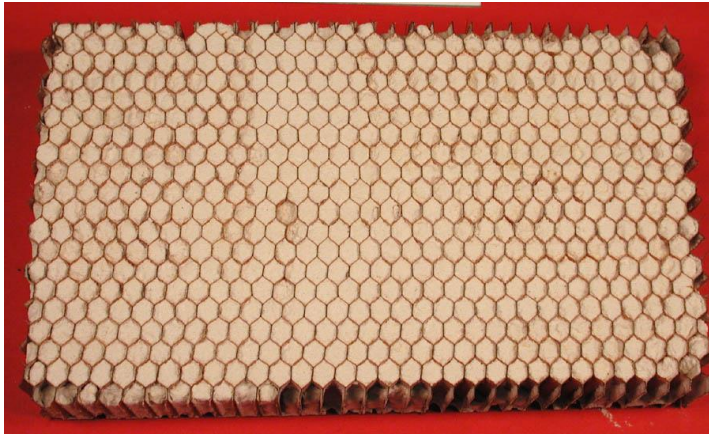
- Machined surface must be sealed with tape or sealer





Materials

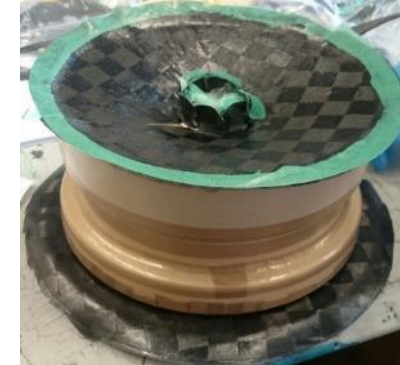
- Aquacore for Honeycomb Stabilisation





Mandrel for Carbon Rim

- Rim size Ø 10" x 7"
- Weight 1.35kg
- Rim profile according DIN 7817
- Made of Carbon Prepreg on a Rapidcore Mandrel with outside tool





Mandrel for ANYmal Robot

- Aqua Mandrel used for Carbon legs
=> lightweight, high stiffness and cable integration

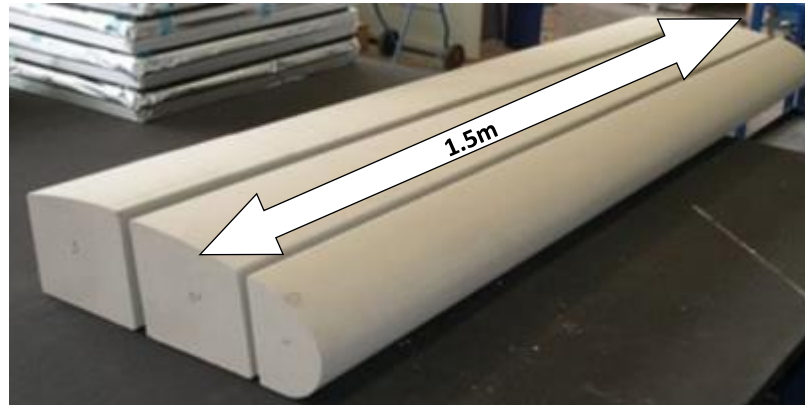


www.wysszurich.ch



Products

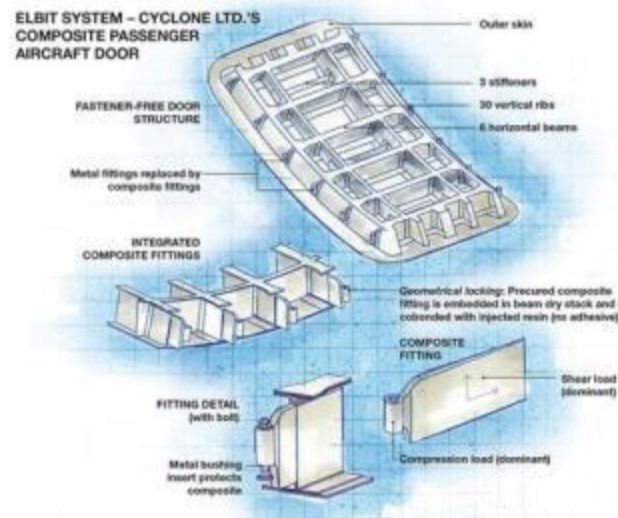
- Manufactured Mandrels



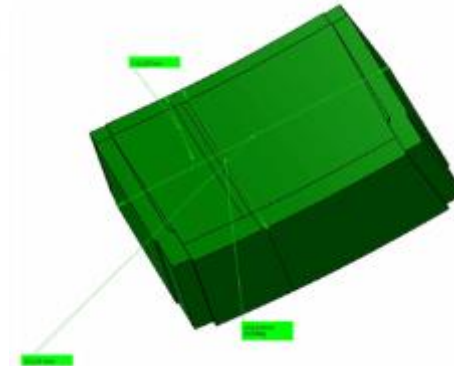


Applications

- Hollow Door Structures
- Door Hinges
- Airducts
- Stringers



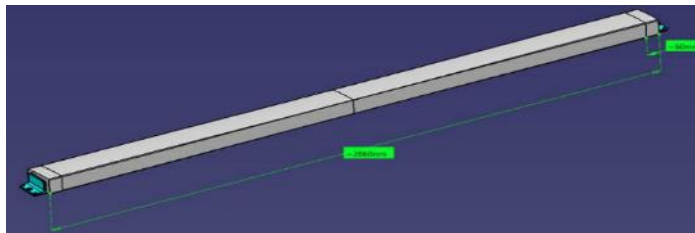
Example: compositesworld.com 201307



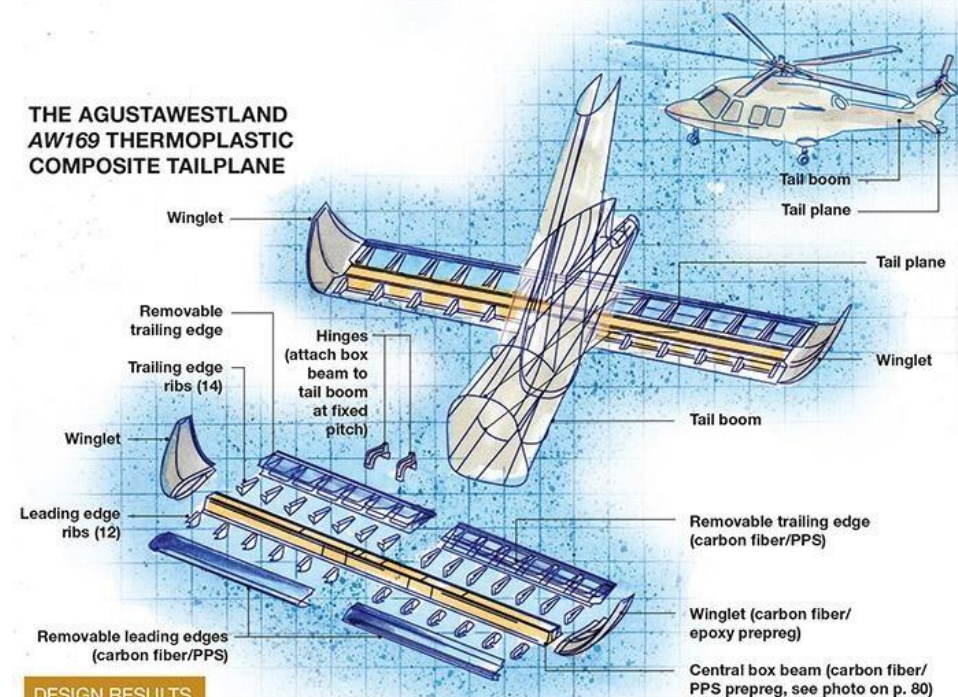


Leonardo Helicopters Horizontal Stabilizer

- AW169 Longeron mandrel length approx. 3000mm
- Incl. very accurate positioning system
- Prepreg co-curing system @ 180°C



THE AGUSTAWESTLAND
AW169 THERMOPLASTIC
COMPOSITE TAILPLANE



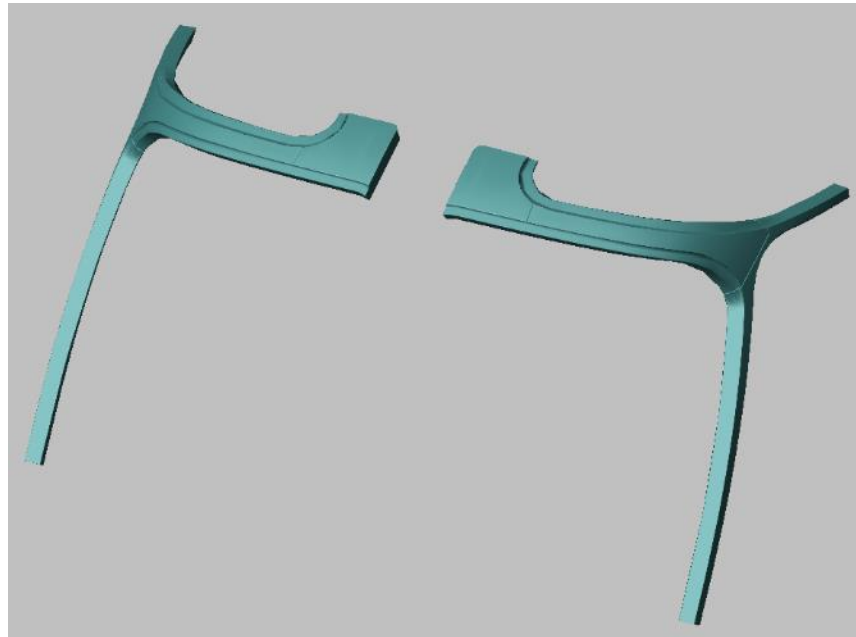
DESIGN RESULTS

- Easily formed omega-section box beam, made of carbon/PPS prepreg, resists bending and torsional loads.
- Use of a prequalified thermoplastic prepreg reduces risk yet increases toughness and durability in complex rotor wash environment.
- Thermoplastic tailplane's removable leading and trailing edges ease maintenance and repair.



Leonardo Helicopters Canopy Frame

- AW169 Canopy mandrel left and right
- Mandrel in complex 3D geometry
- Carbon Fibre Prepreg autoclave system





Aircraft Passenger Door Hinge

- Different mandrel shapes



- Wash-out station

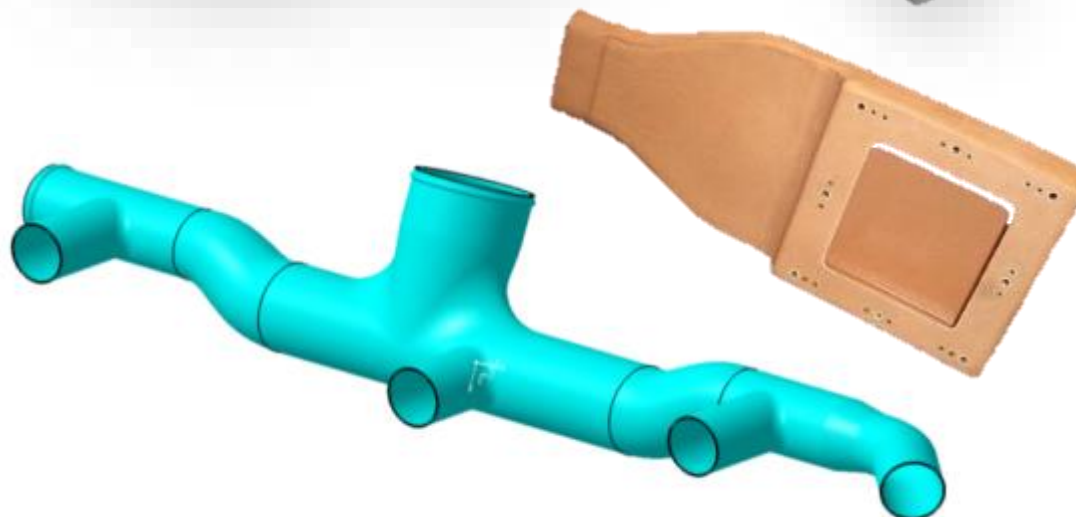


Door assembly





Air-/Cableducts





Airducks

- Different Airducks



Missile Airduct





Landing Flap

- 1.5m length

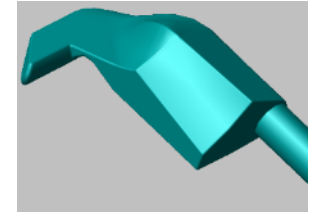
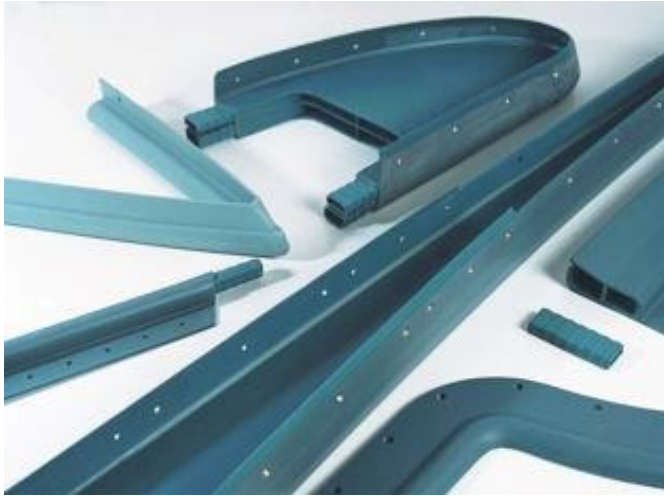


- RTM Processing





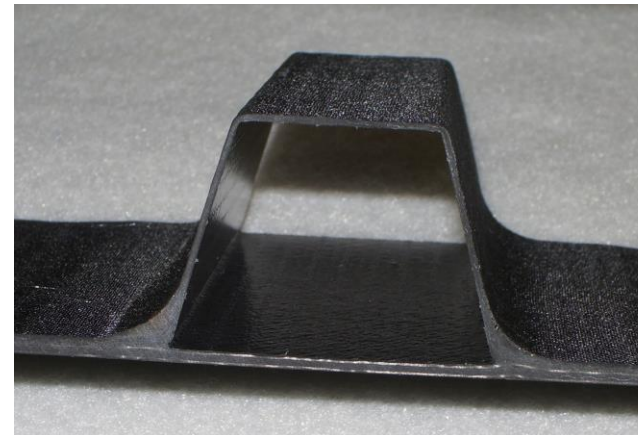
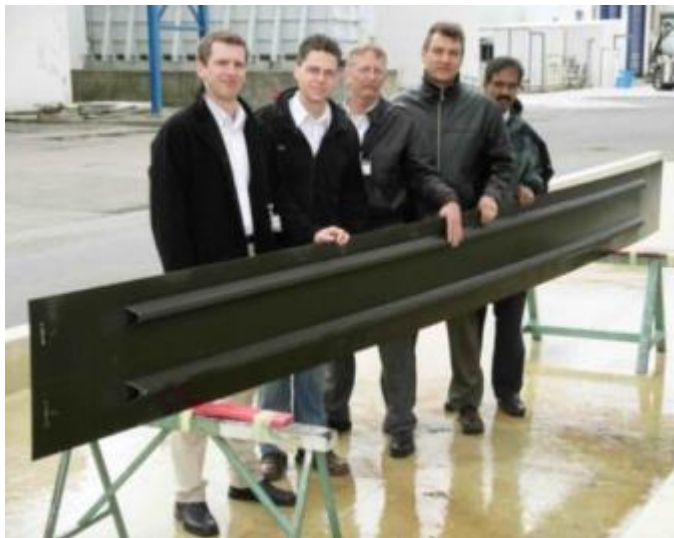
Reinforced Silicone Sealings





Omega Stringer

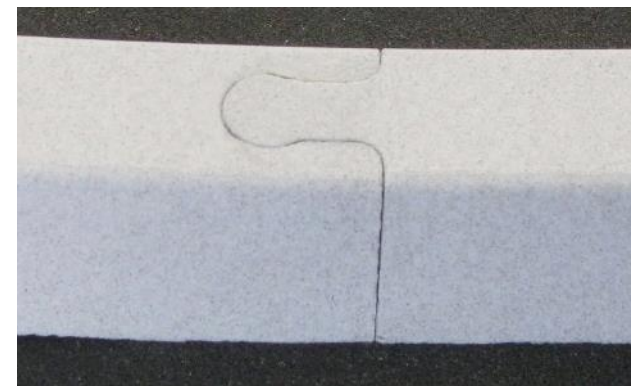
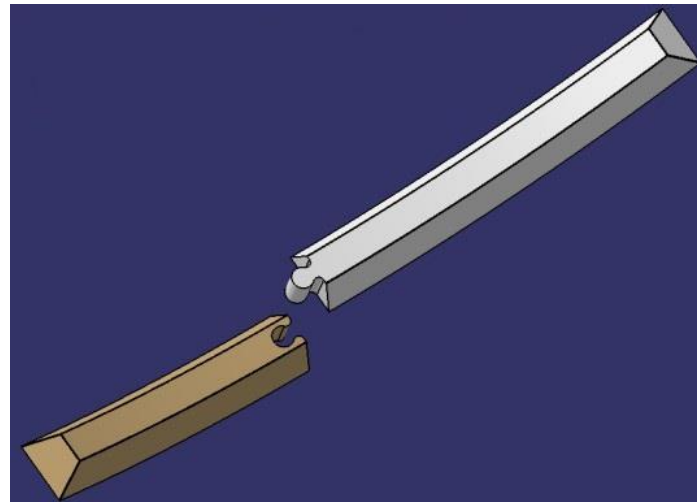
- Up to 7m length





Jigsaw Joint for Omega Stringer

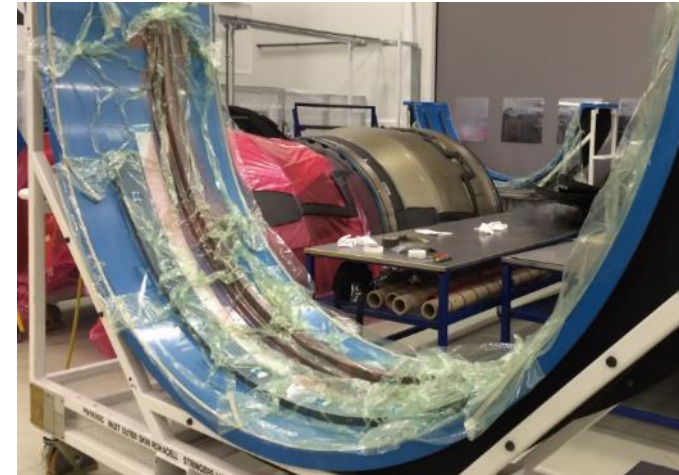
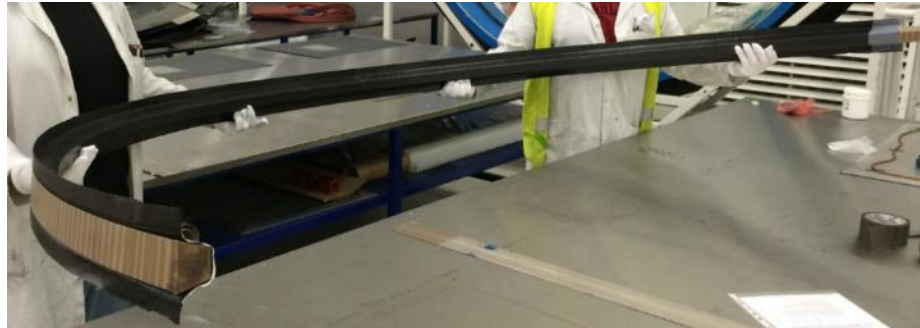
- No additional adhesive for joining necessary
=> saves cost and labour





FanCowl Door Project with Omega Stringers

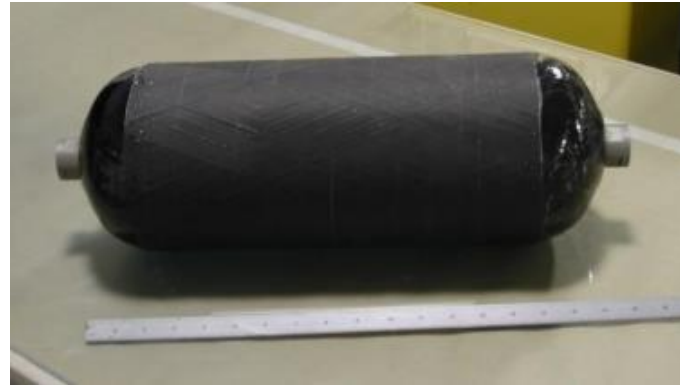
- Mandrel length > 4000mm
- Prepreg co-curing system @ 180°C





Pressure Vessels

- Mandrel made from block or with mould



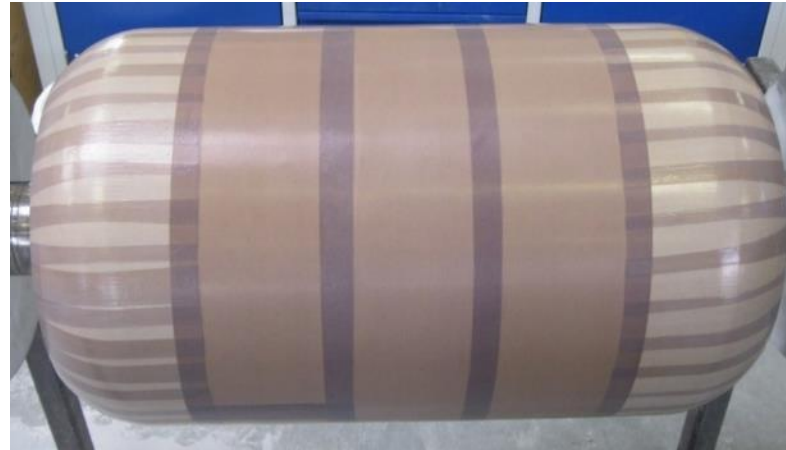
- Composite processing by winding or tapelaying





Pressure Vessels

- Aqua mandrel
approx. Ø400x800mm
for applications at 180°C



- Cavuscore mandrel
approx. Ø600x1000mm
for Thermoplastic applications
at 400°C





Thermoplastic Pressure Vessels

- Cavuscore mandrel sealed with Polyimide tape
- Automated Fiber Placement (AFP) process with laser heating
- Oven consolidation at 380°C



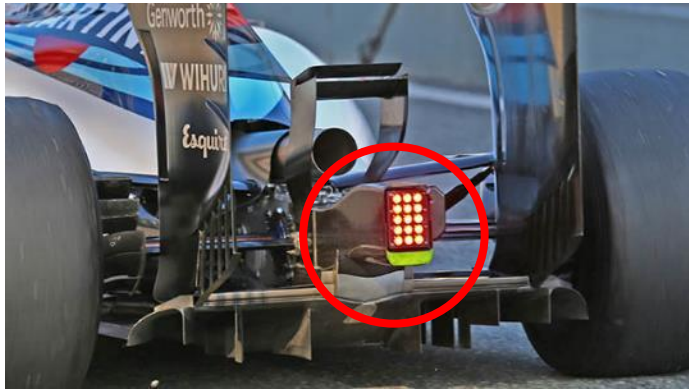


Automotive Parts





Automotive Parts



Rear Crash Structure



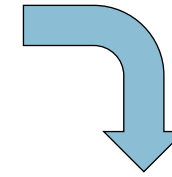
Front Nose Section





Cavuscore

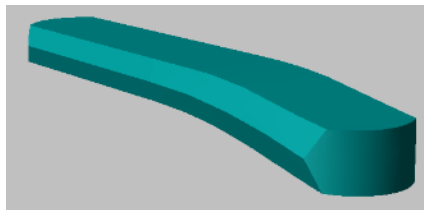
- Water soluble
- Very fast wash-out
- Density 1.5-2.0 gcm-3
- Low CTE 7.1-14.0 E-6 K-1
- Temperature resistant >300°C
- Pressure resistant 200 bar
- HP-RTM, Thermoplastic (PEEK), Hot Pressing, Injection Moulding
- Recyclable
- Machinable
- Prototyping – Serial Production





Cavuscore Thermoplastic Applications

- Hot-pressing process
- Curing temperature $>250^{\circ}\text{C}$
- Pressure $\pm 50\text{bar}$
- Curing time 60min
- Washout hole $\varnothing 4\text{mm}$, just water!
- Even no sealing necessary!



Thermoplastic application

Ensinger

AQUA
MANDREL



Logistics / Serial Production





Selection of Customers



Thank you.

Aero Consultants

For more information, contact us:

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