Development of Three-dimensionally Heat Conducting Carbon Composites

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Aerospace Technology Congress 2019, Stockholm, Sweden

Enlarging Non-laminated Composite’s Market

Biteam AB, Stockholm and Fureho AB, Borås – Swedish SMEs

Specialized in developing and manufacturing near-net shape 3D fabrics/preforms

Proprietary non-conventional techniques and equipment to suit different application needs

Direct production of 3D preforms with customized shape and features

Wide range and types of products not realized earlier

Increasing performance-reliability of composites and enabling their automated production

Pitch Carbon Fibres

Two types of carbon fibres: PAN and Pitch

Pitch carbon fibres have higher thermal conductance than PAN carbon fibres

Pitch carbon fibres: 140-800 W/mK

PAN carbon fibres: 20-150W/mK

(along fibre axis; transverse direction: 0.5-0.8 W/mK)

W/mK:

Stainless steel – 13.5	Copper – 398
Titanium – 17	Graphite sheet – 1416
Aluminium – 226	Diamond – 2000

Negative to very low

Coefficient of Thermal Expansion

Highly stiff fibres: 420 – 900 GPa

(PAN stiffness: 230 - 440 GPa)

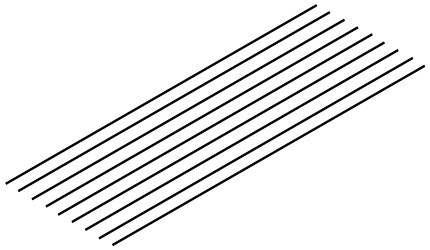
Brittle – easily damaged and broken

Pitch Carbon Fibre Reinforcements

Textile reinforcement types:

Unidirectional

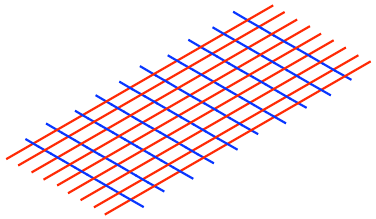
X - fibre orientation



Laminate;
Heat conductance in
one direction

2D Fabric

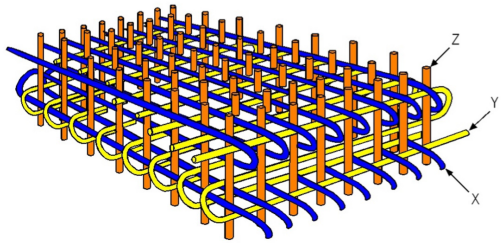
XY - fibre orientations



Laminate;
Heat conductance in
two directions

3D Fabric

XYZ (and ±θ) - fibre orientations



Non-laminate;
Heat conductance in
three directions

New challenges in processing brittle pitch fibres into 3D fabric reinforcements

Pitch Carbon Fibre 3D Preform Production

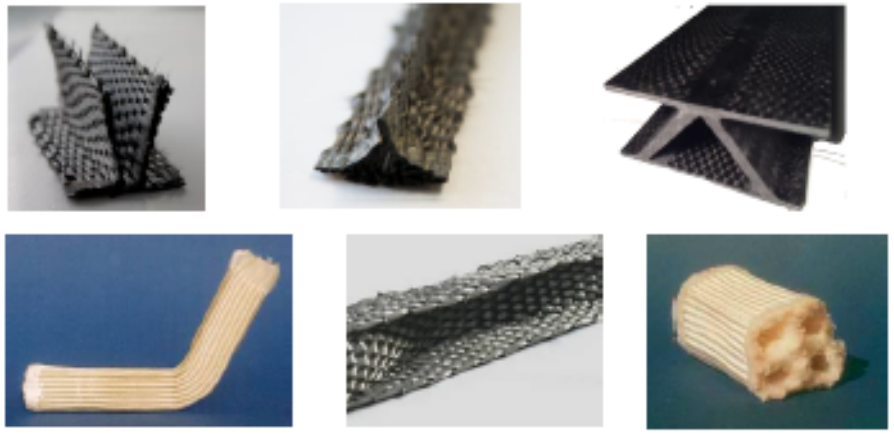
Traditional textile processes are unsuitable for processing brittle fibres into 3D fabrics

Innovative 3D fabric-forming techniques developed to process most fibre types

BITEAM

Dual-directional and Add-on Weaving Processes

for profiled, channelled beams; Continuous process

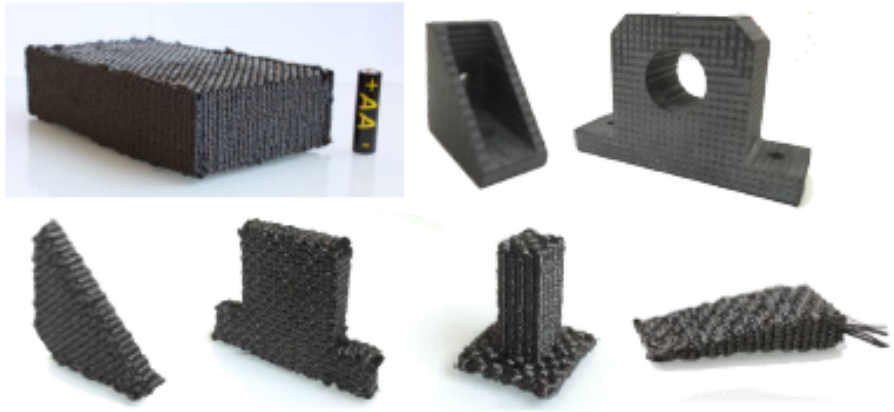


- *High delamination resistance*
- *Near-net shaped*

fureho

Noobing Processes (Non-woven)

for objects close to required shapes; Individual objects



- *Customized performance*
- *Machinable composites*

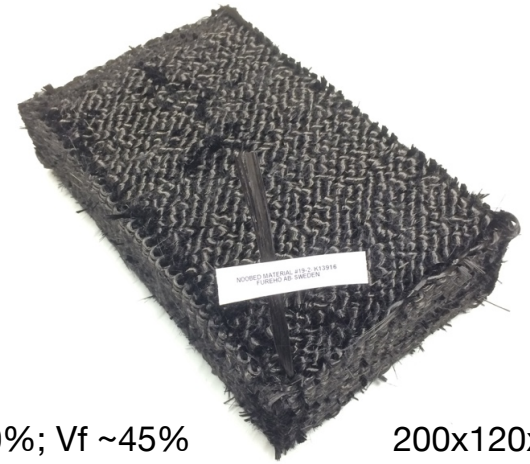
Pitch Carbon Fibre 3D Preforms Developed

D-D Woven Pitch T Profile

50-25-25%; Vf ~40%

20x30 mm

Noobed Pitch Block



40-40-20%; Vf ~45%

200x120x50 mm

Thermal conductivity in XYZ directions customizable through fibre distribution

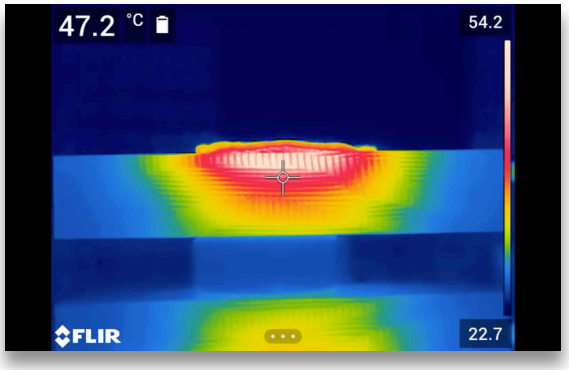
• Dialead K13916 fibres (Mitsubishi Chemical) • Thermal conductance 200W/mK • 16k tow • Ultra-high modulus 760 GPa

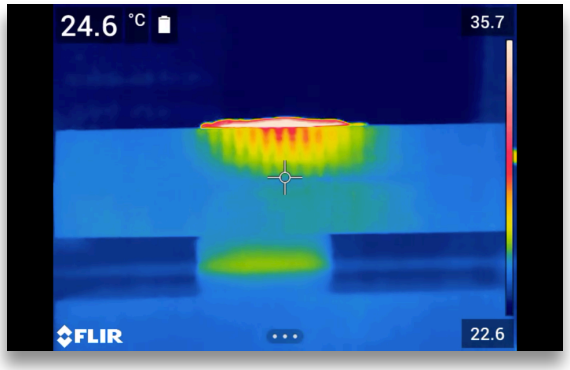
Three-Dimensional Heat Conductance in Noobed Blocks

Pitch Carbon Fibre Noobed Block

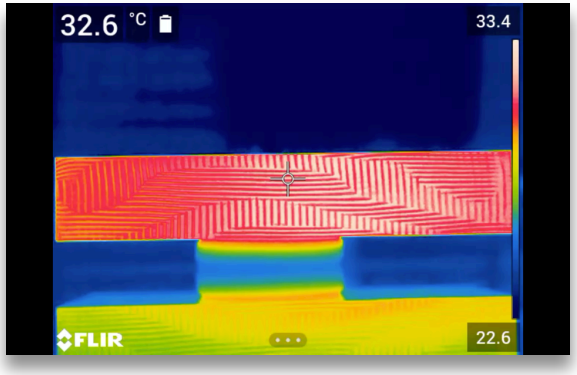
PAN Carbon Fibre Noobed Block

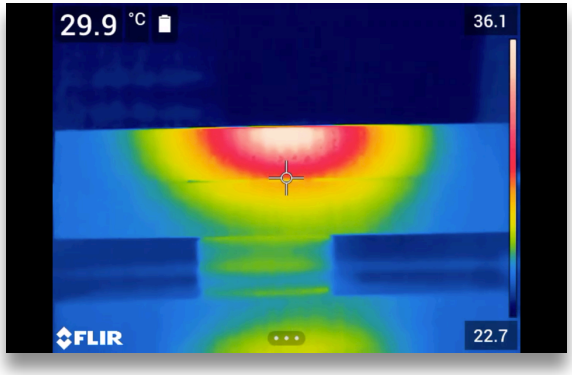
At 6 seconds





At 120 seconds





"Black metal"

X and Y directions: 27W/mK
Z direction: 13W/mK

Possibilities with Pitch Carbon Fibre 3D Composites

Advantages:

- Thermal conductance in three directions
- High dimensional stability of the component/part due to zero-CTE (aluminium is 23CTE)
- Quick vibration/oscillation damping due to stiffness

Possible applications:

- Heat conductors (electronics, electrical, mechanical systems, spacecraft radiators, brakes, de-icing)
- Components requiring stiffness (optical imaging/photographing equipment, telescopes, high precision measuring equipment, high-speed components)
- Systems requiring virtually vibration-free working (extending/moving arms, positioning systems)
- Beams for spatial frameworks, structures and special constructions

Acknowledgements

Sumitomo Corporation Europe Limited, UK

FNB Consulting, Germany

Corebon AB, Sweden

Lund University, Sweden