Kolfiberarmering för avancerade tillämpningar

2012-10-10

TeXtreme®

Business Idea

- Oxeon develop produce and sell optimized spread tow reinforcement solutions, TeXtreme®, to customers with a need for ultra light weight and high performing advanced composites.

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Oxeon

TeXtreme®

The basic idea with Spread Tow Reinforcements

- By weaving with flat tapes, instead of yarns, the crimp in the fabric is reduced and thereby the mechanical performance of the composite is significantly improved.

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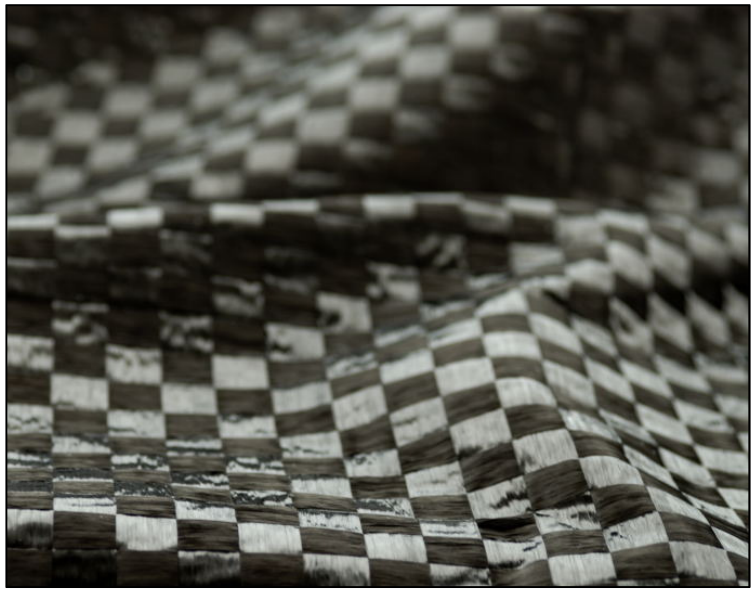
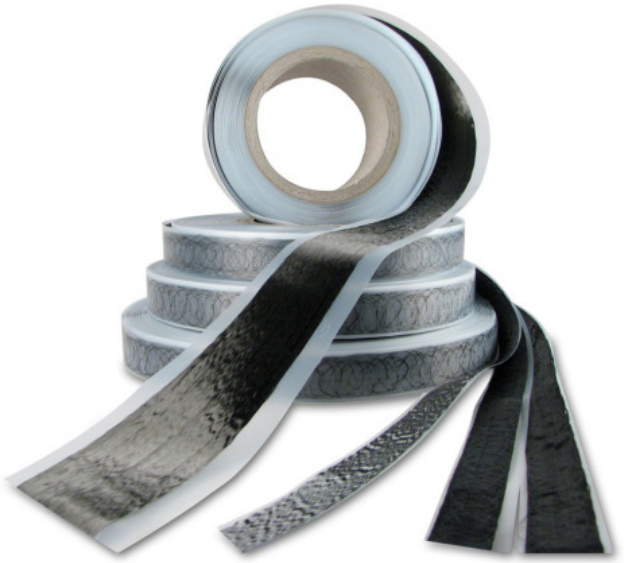
Spread Tow Fabrics



Spread Tow Tapes



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About TeXtreme®

TeXtreme® STT

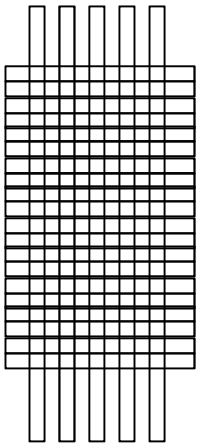
UD (90)

Starting point is the Spread Tow Tape (STT) which can be optimized with respect to:

- Fiber type – carbon, zylon, aramid, etc
- Fiber modulus – HS, IM and HM
- Tape width
- Areal weight
- Binder type

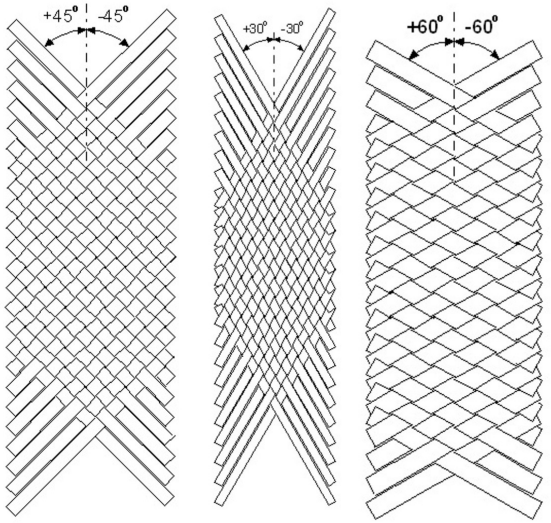
TeXtreme® STF

Biaxial (woven) 0/90



By tailoring each individual tape, an optimized fabric construction with endless variations can be achieved

Biaxial (woven) +α/-β



The fiber orientation can be optimized in e.g. 0/90, +/-45, +30/-60, +37/-54 etc

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Spread Tow Tapes

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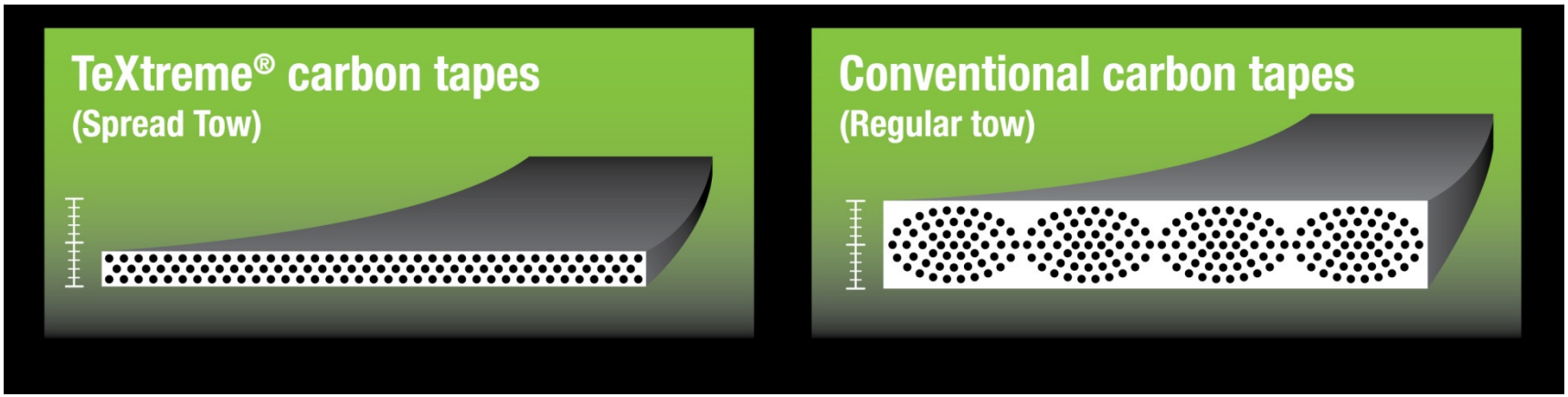
Spread Tow Tapes



Ultra light; from 21 gsm

Ultra thin; ~0,02 mm per ply

HS, IM and HM fibers

Improved fiber alignment in and out of the plane

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Spread Tow Fabrics

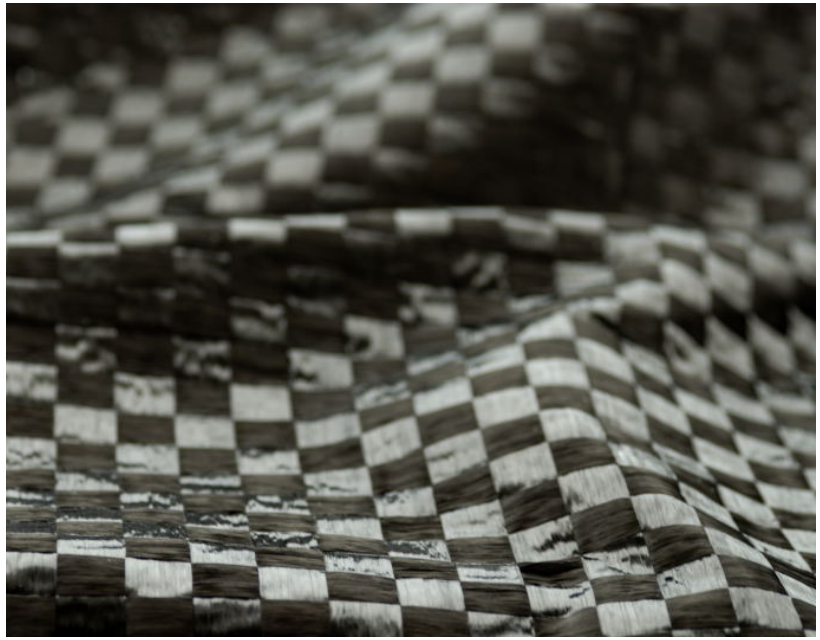
Bi-axial reinforcement

Woven with 20-50 mm wide tapes

Ply thicknesses from ~0.04 mm

From 12k tows or heavier

HS, IM and HM fibers



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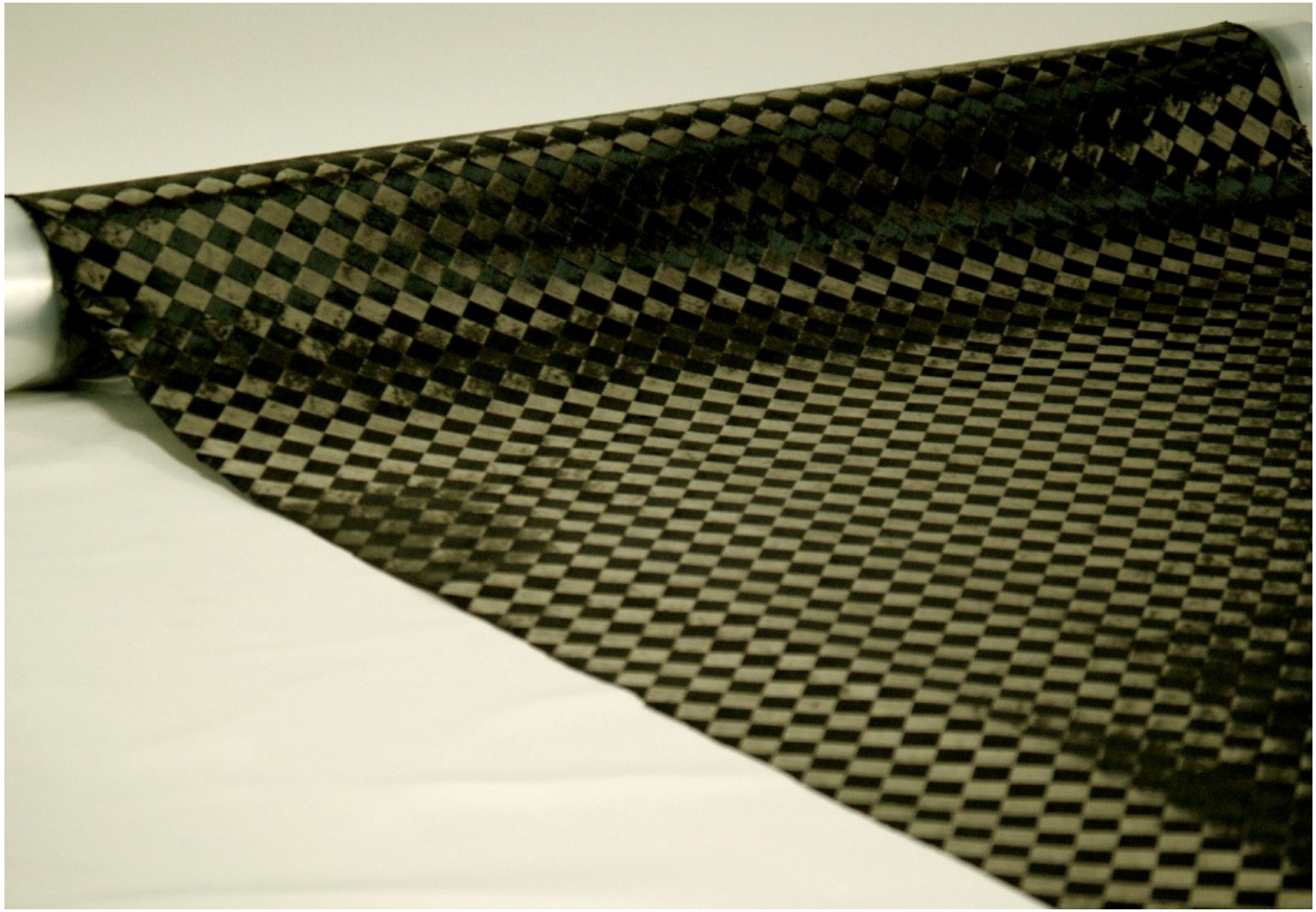
+α/-β Spread Tow Fabrics



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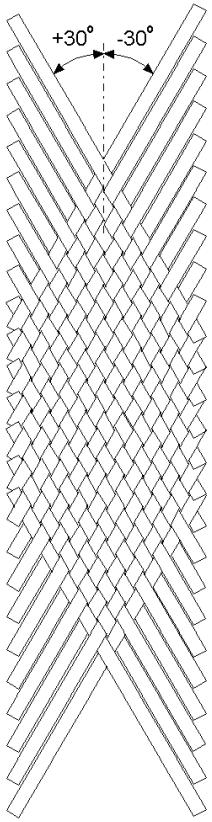
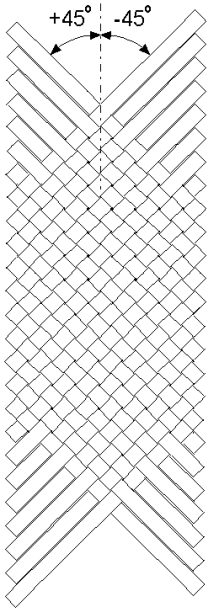
+α/-β STF Variants

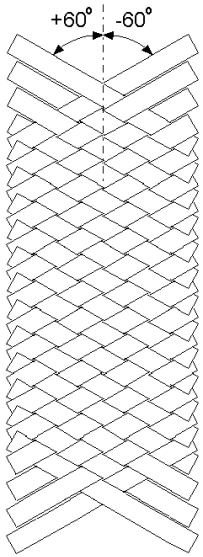
Acute angled



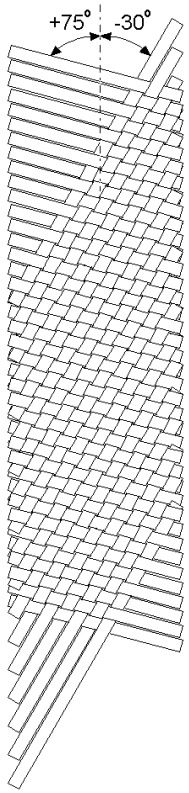
Right angled



Obtuse angled



Mixed angled



Equal Angels

Unequal Angels

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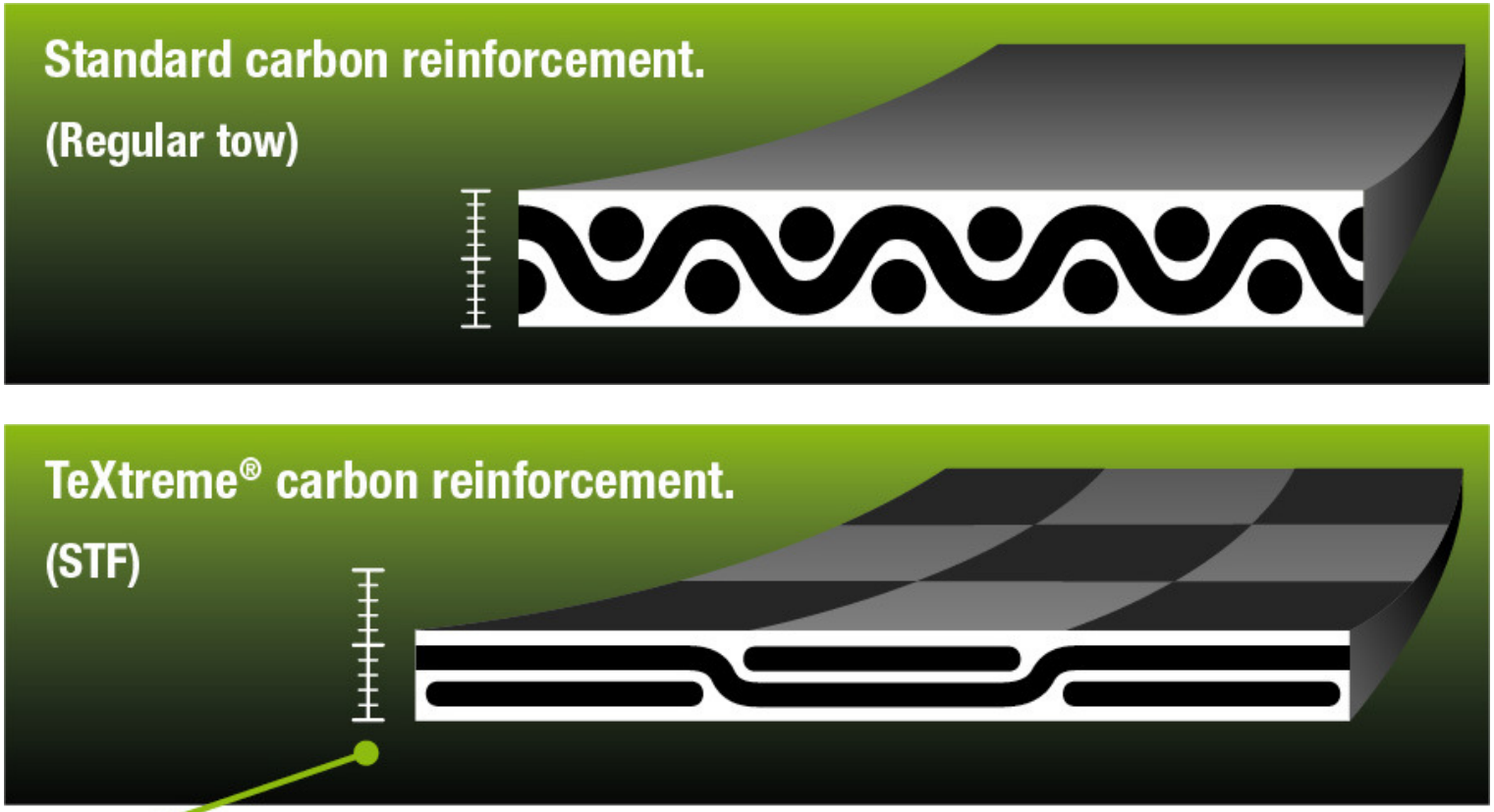
Spread Tow Fabrics



1 Thin Fabrics
High Vf

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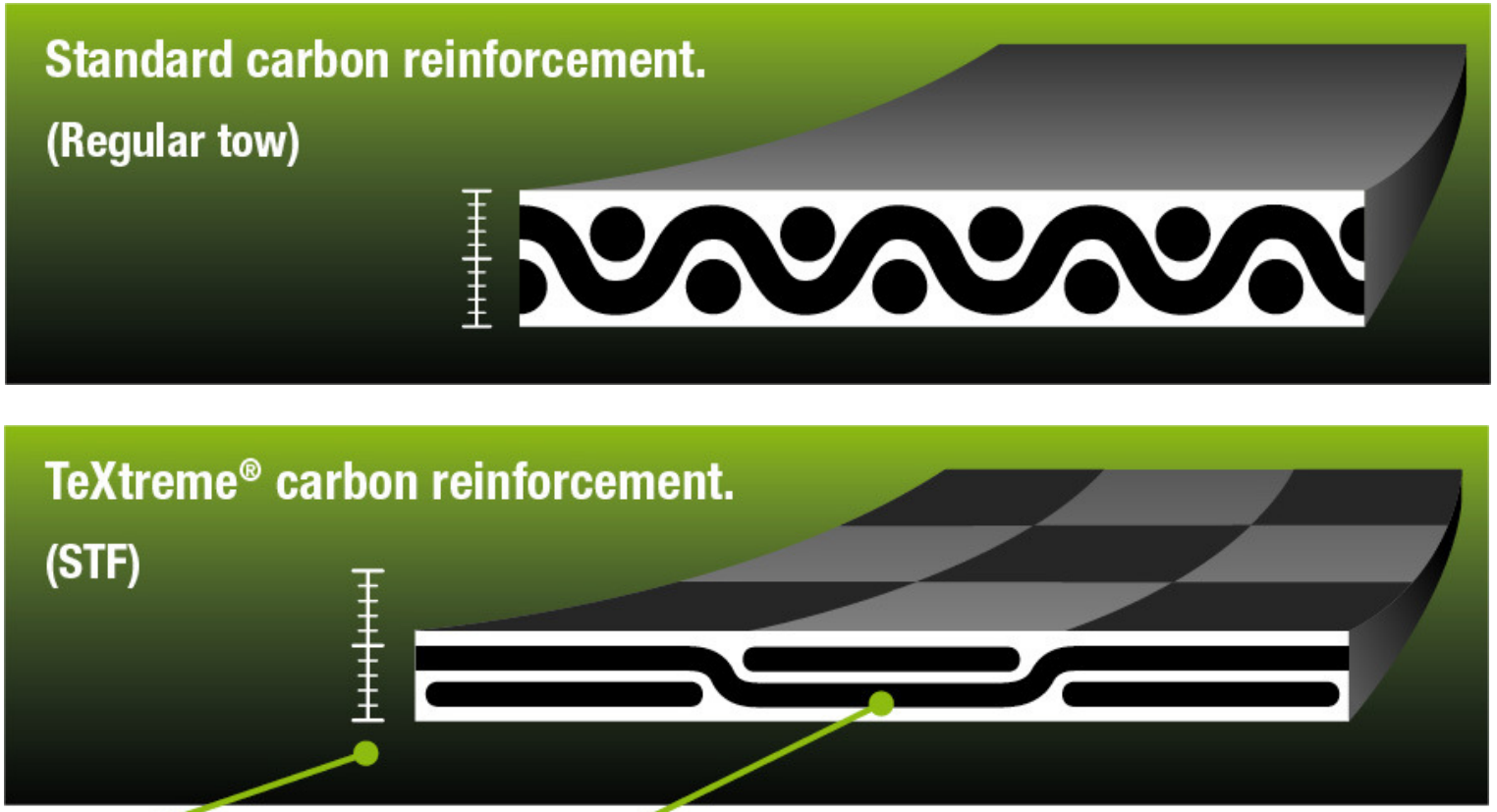
Spread Tow Fabrics



1 Thin Fabrics
High Vf

2 Straight Fibres
Improved Performance

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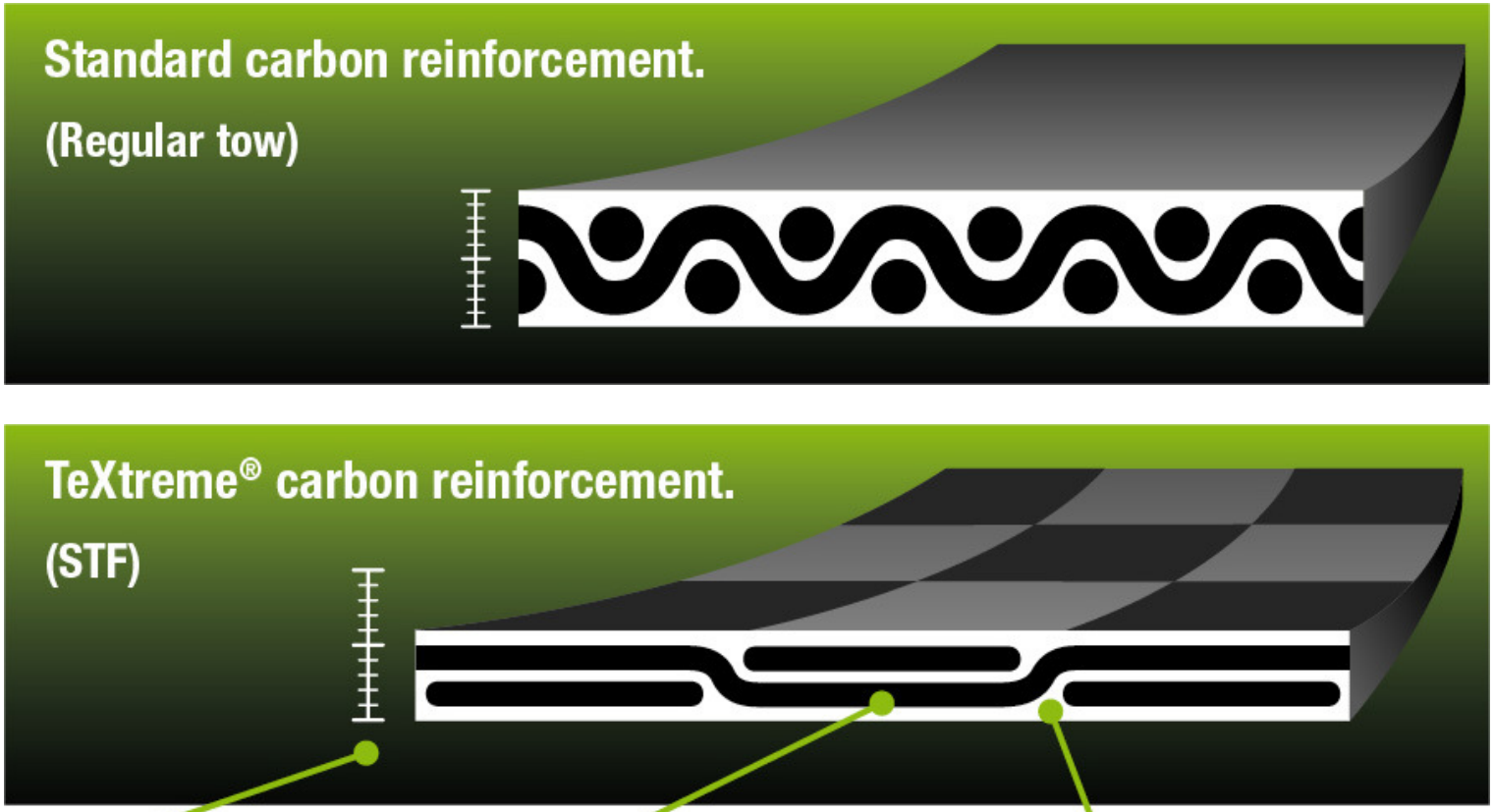
Spread Tow Fabrics



1 Thin Fabrics
High Vf

2 Straight Fibres
Improved Performance

3 Fewer and Smaller Crimp
Reduced Weight

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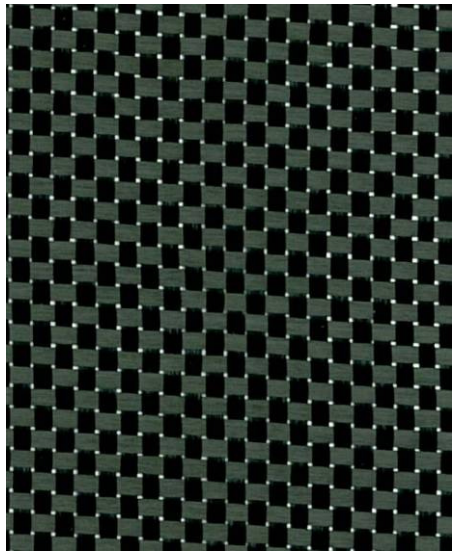
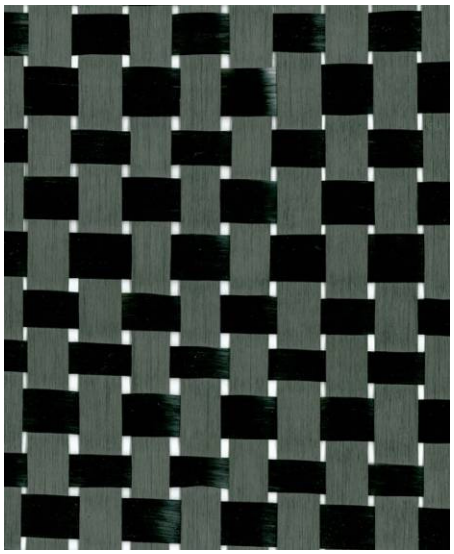
Cover Factor / Excessive resin consumption

Small Tow Fabric



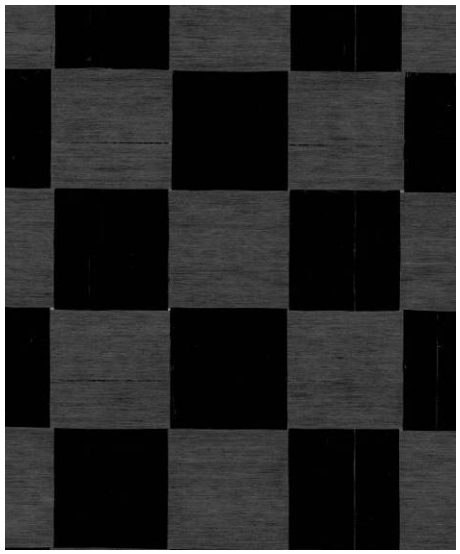
1k Tow
95 gsm

Flat Tow Fabric



12k Flat Tow
160 gsm

Spread Tow Fabric (STF)



12k Spread Tow
80 gsm

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Flexibility

Fibre producer	Fibre product	Tow counts available
Tenax	HTA40/HTS40	1k, 3k, 6k, 12k, 24k
Toray	T300	1k, 3k, 6k, 12k
Hexcel	AS4	3k, 6k, 12k
Formosa	TC33	1.5k, 3k, 6k, 12k, 24k
Mitsubishi Rayon	TR50	6k, 12k, 15k, 18k

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Flexibility

Fibre Type and Tow Count	Traditional Woven Fabrics - gsm	Spread Tow Fabrics - gsm
HS - 1k	90 – 120	-
- 3k	200 – 400	-
- 6k	300 – 500	-
- 12k	500 – 600	64 – 400
IM - 6k	200 – 400	-
- 12k	300 – 400	43 – 250
- 18k	not available	76 – 300
- 24k	not available	80 – 300
HM - 6k	200 – 500	-
- 12k	300 – 500	130 – 245

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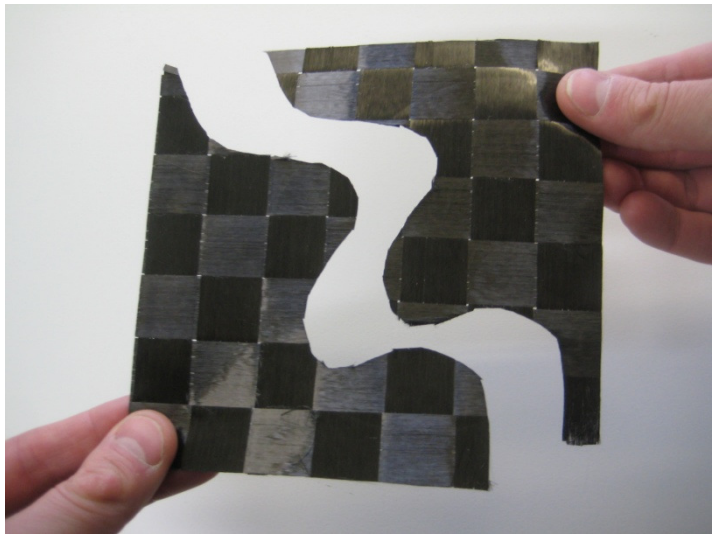
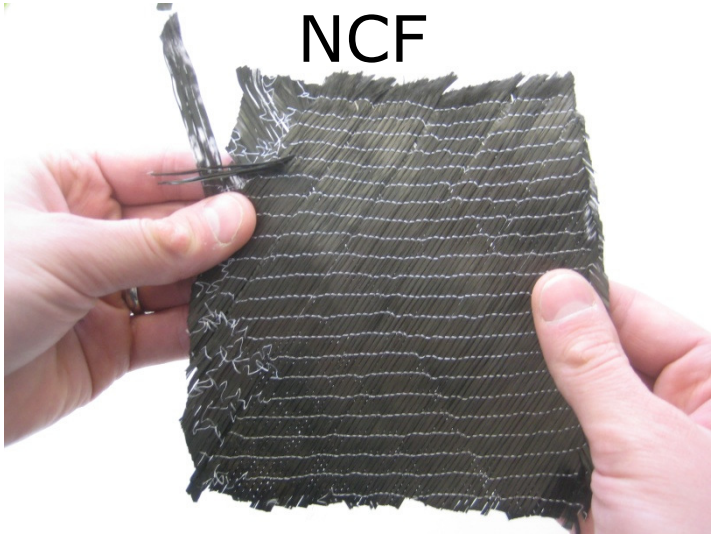
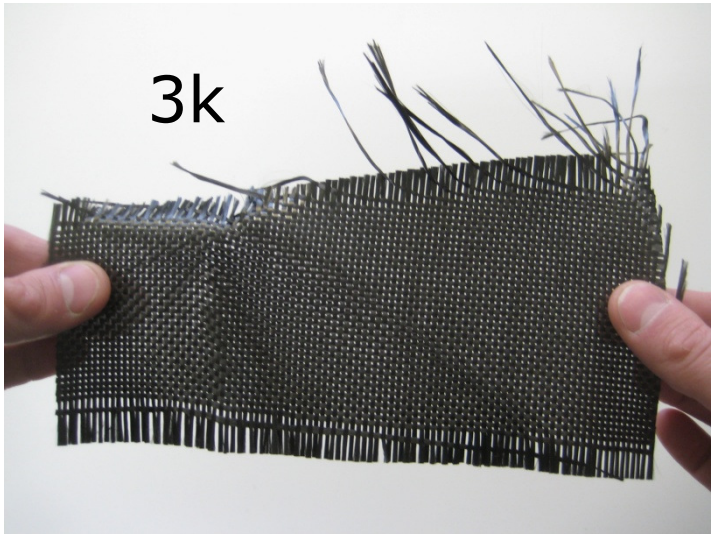
Handling ability and Automated processes



Preforming





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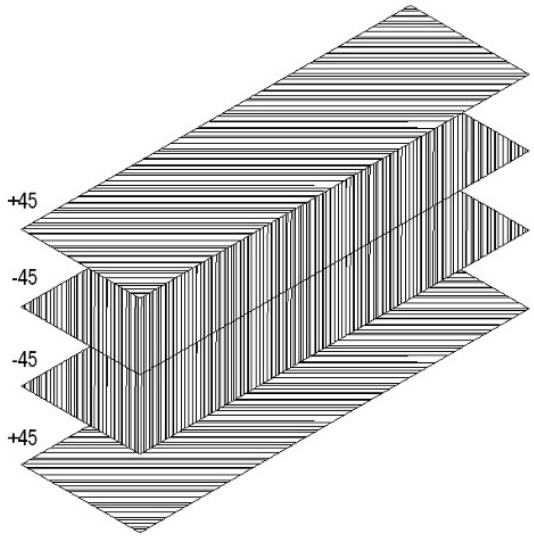
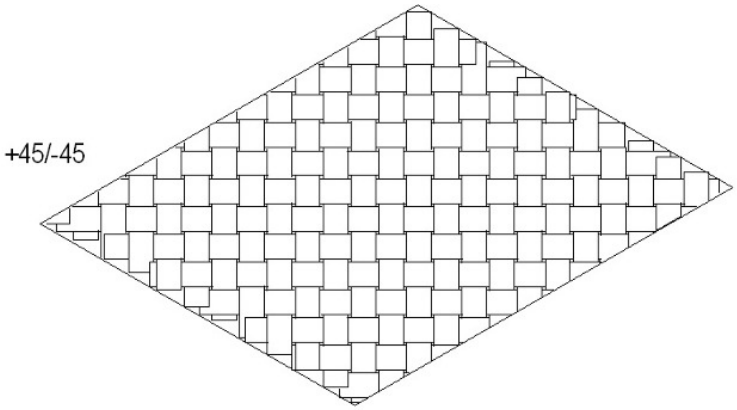
Symmetrical Bi-Directional Construction

Material	Ply sequence	No. of fiber layers to achieve symmetry
UD	[+45/-45/-45/+45]	4
NCF	$[NCF_{(+45/-45)}/NCF_{(-45/+45)}]$	4
STF	$[STF_{(+45/-45)}]$	2



UD



STF

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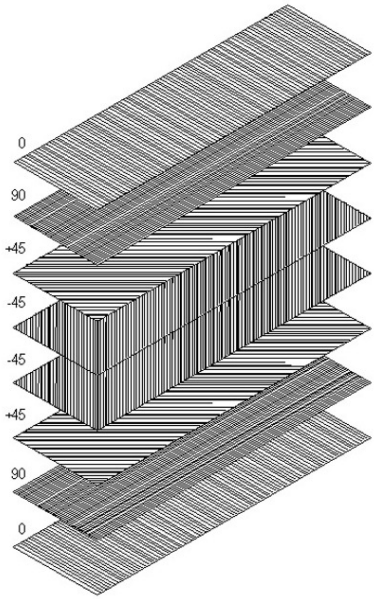
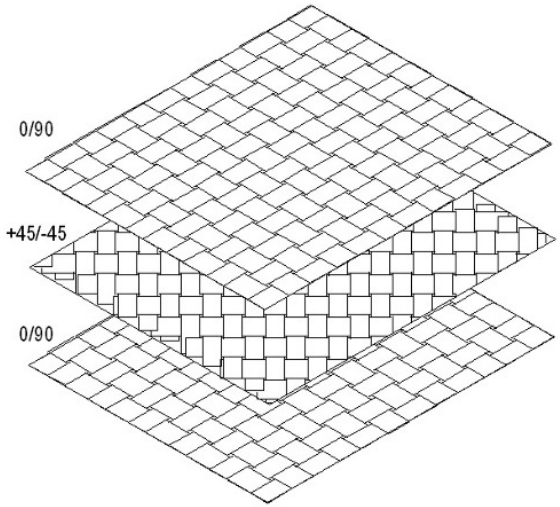
Symmetrical Quasi-Isotropic Construction

Material	Ply sequence	No. of fiber layers to achieve symmetry
UD	[0/90/+45/-45/-45/+45/90/0]	8
NCF	$[NCF_{(0/90/+45/-45)}/NCF_{(-45/+45/90/0)}]$	8
STF	$[STF_{(0/90)}/STF_{(+45/-45)}/STF_{(0/90)}]$	6



UD



STF

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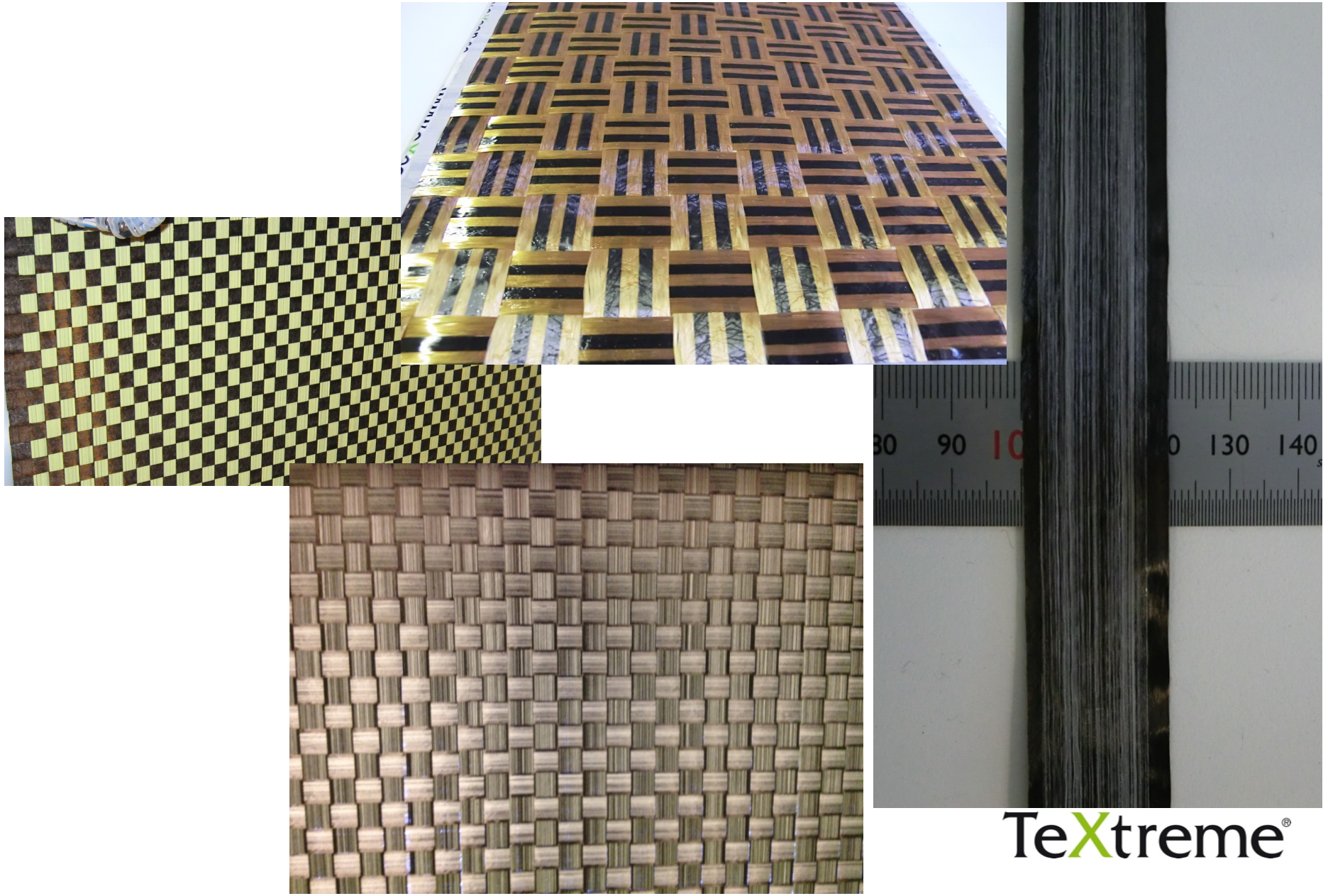
Hybrids



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Materials

Material	Surface weight (g/m^2)	Fiber	Lay-up	Average thickness (mm)
UD	134	(0°) Tenax E HTS 40 12 k (90°) Grilon C85 200 dtex	$[0/90]_{8s}$	2.10
NCF	100	Torayca T700 SC 12k	22 layers	2.52
3k	200	Tenax E HTA 40 3k	12 layers	2.66
1k	93	Torayca T300 1k	24 layers	2.60
TeX	100	Pyrofil TR50S 15k	22 layers	2.07

Vacuum infused with LY556/HY917/DY070 resin

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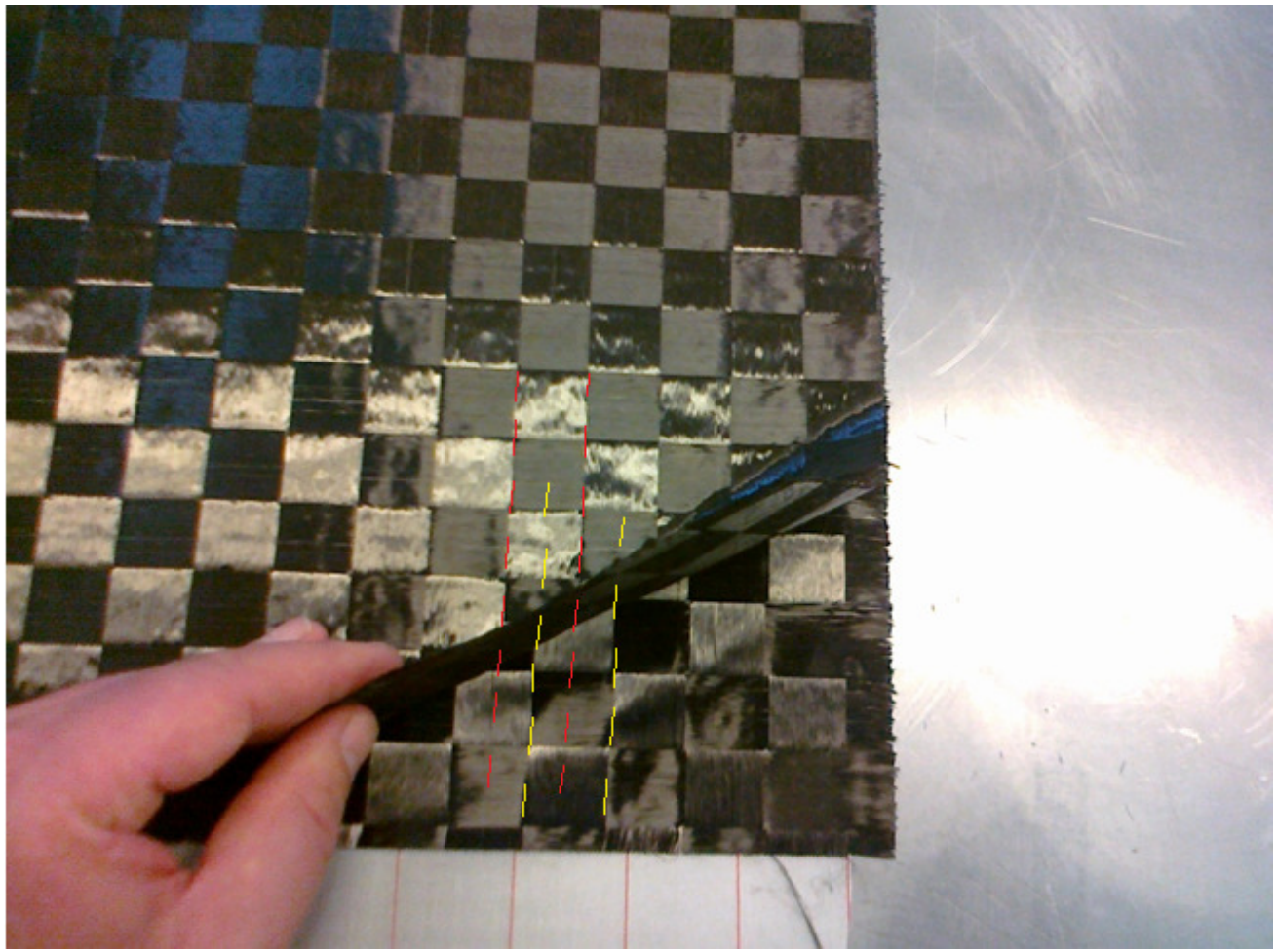
TeXtreme® – lay up



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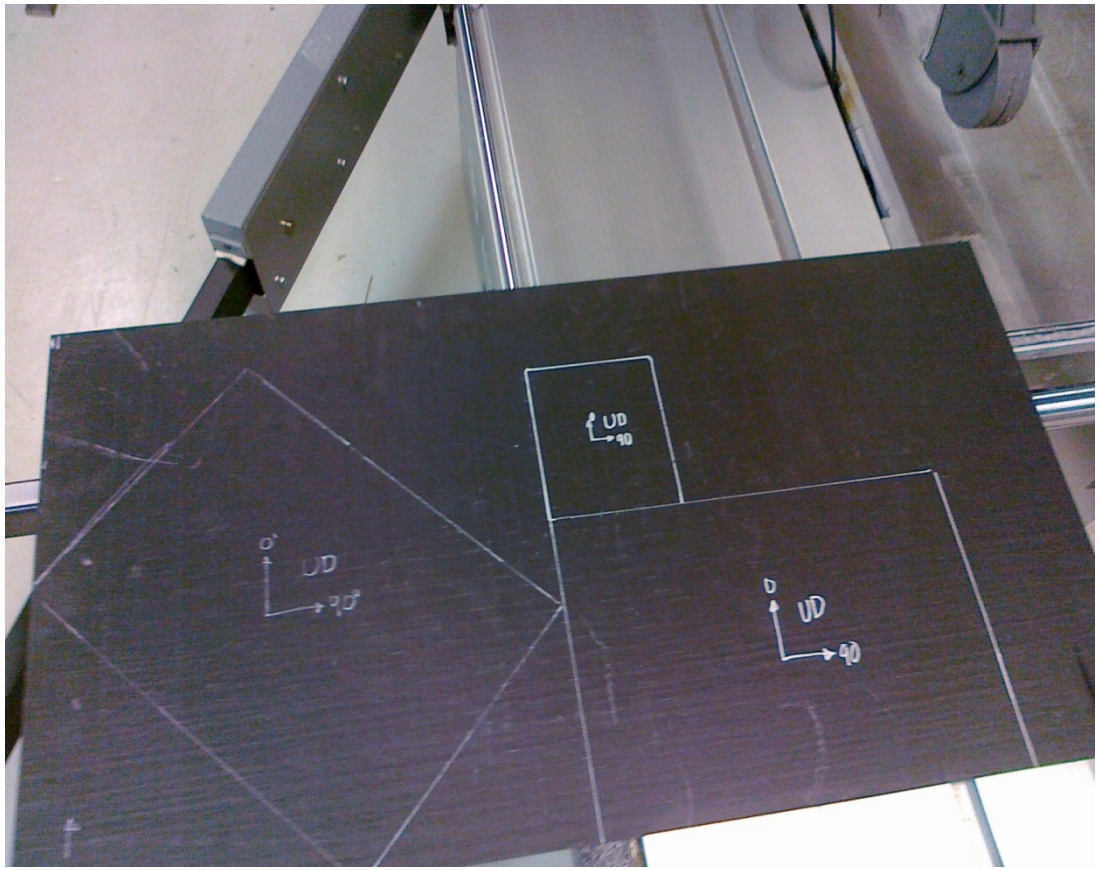
Specimen preparation

- C-Scan
- Less than 2% voids
- Cut to specimen sizes



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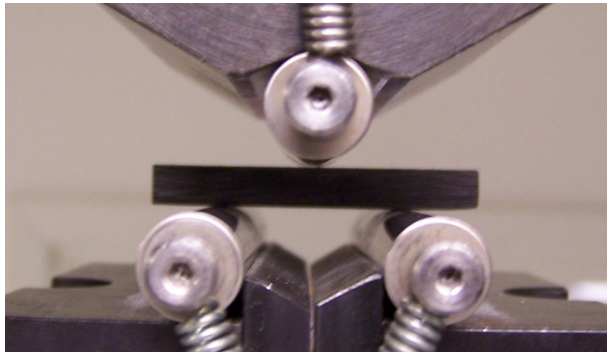
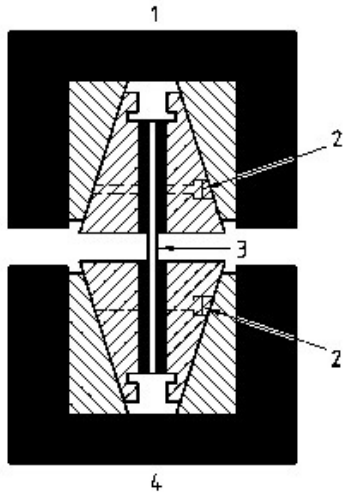
Mechanical tests

- Tensile test, ISO 527
- Compression test, ISO 14026
- Interlaminar Shear test (ILSS), EN 2563
- In-plane Shear test (IPS), ISO 14129:1997





Key

1 Upper housing block
2 Locking screws
3 Specimen
4 Lower housing block

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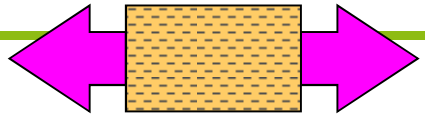

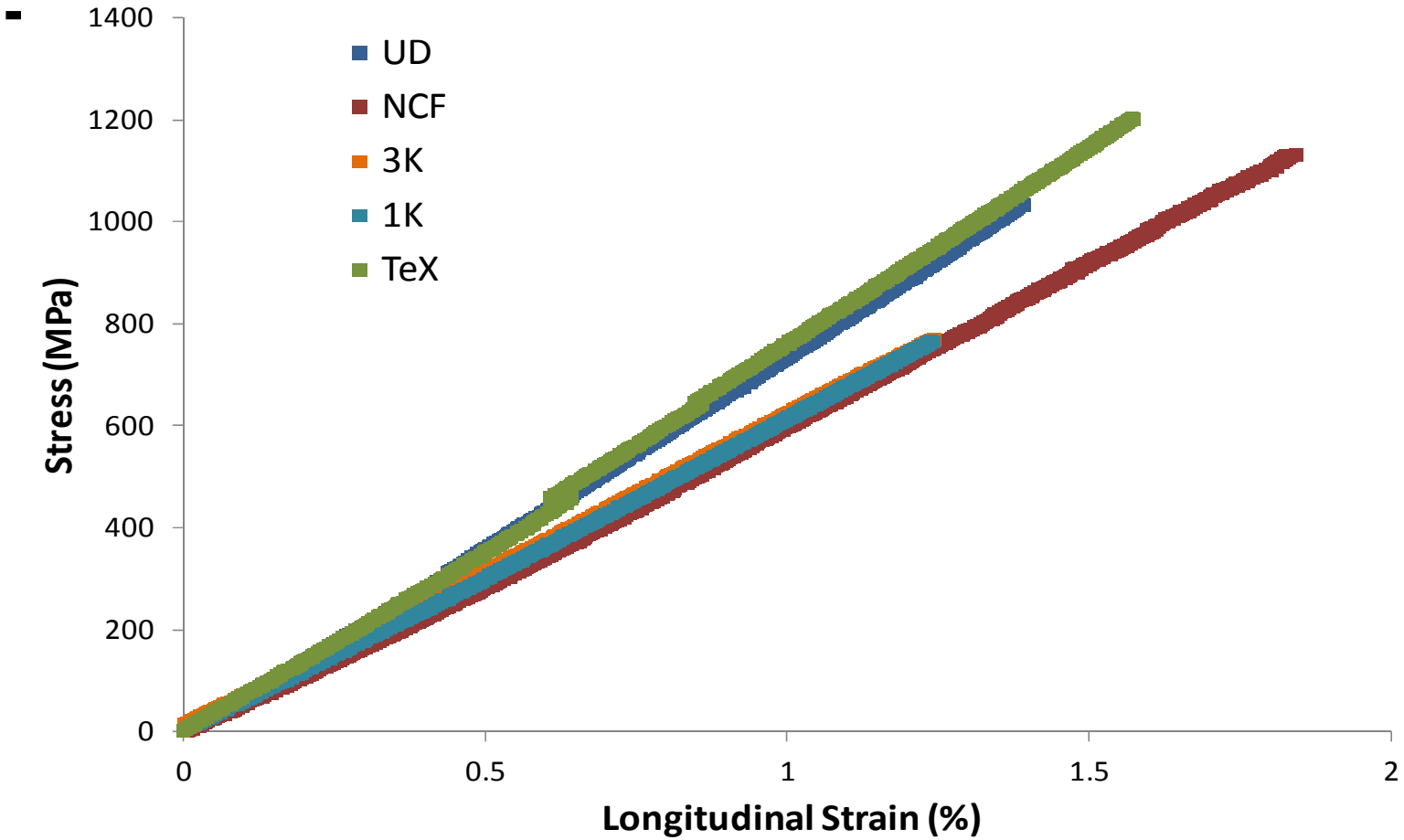
1400
1200
1000
800
600
400
200
0
Stress (MPa)
UD
NCF
3K
1K
TeX
0
0.5
1
1.5
2
Longitudinal Strain (%)

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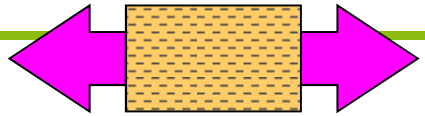

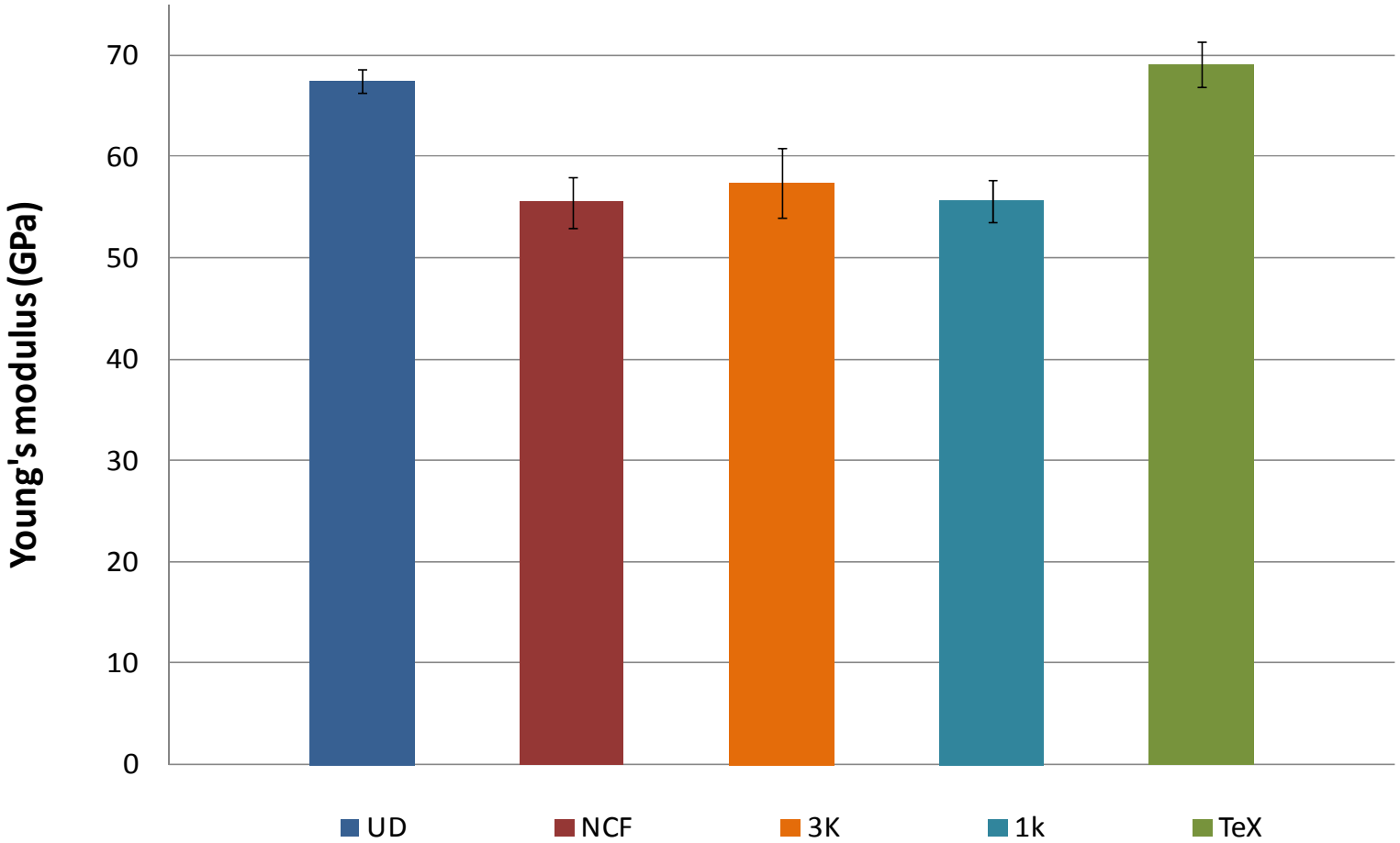

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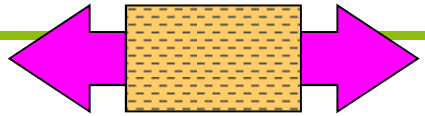

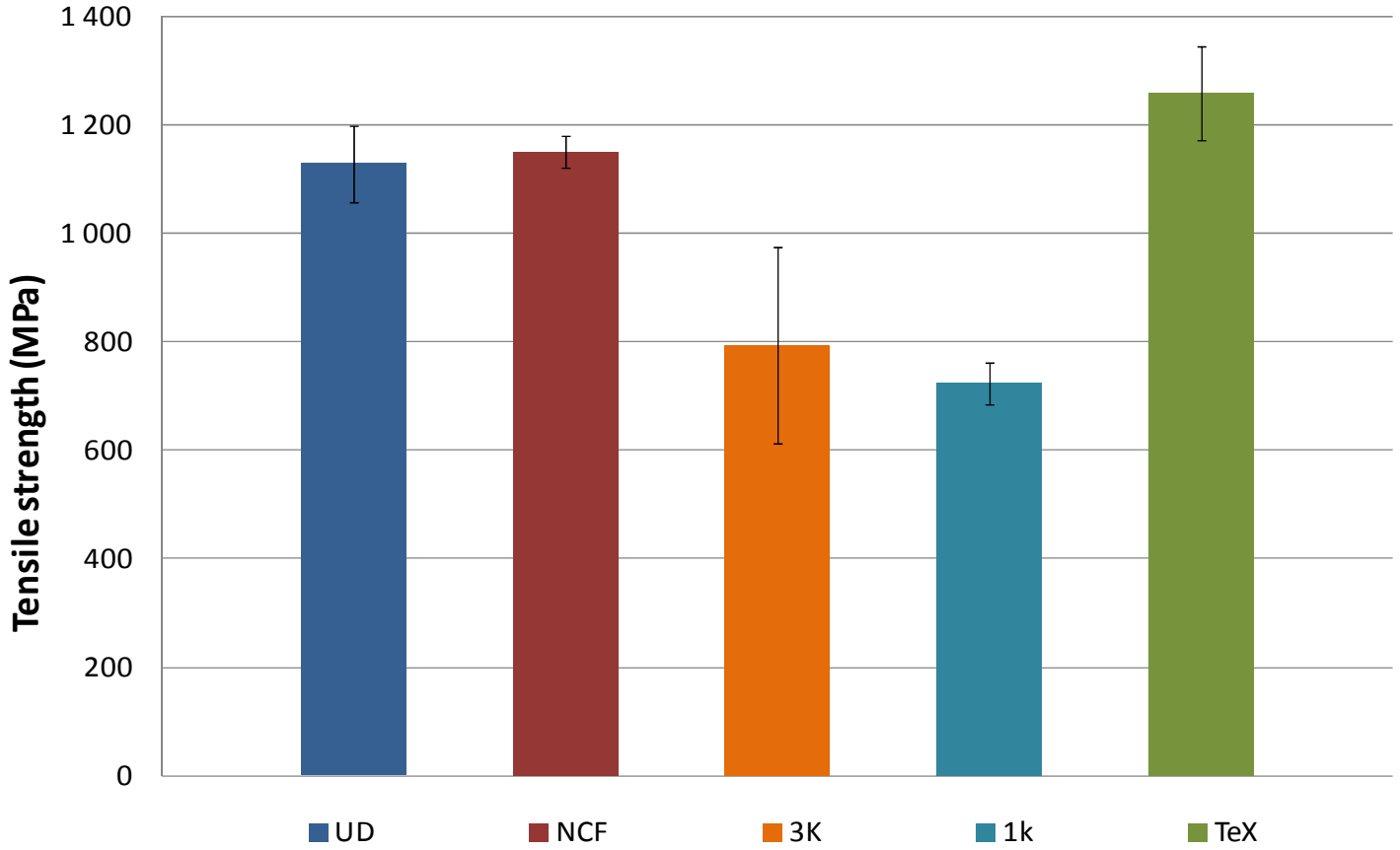
1 400
1 200
1 000
800
600
400
200
0
Tensile strength (MPa)
UD
NCF
3K
1k
TeX

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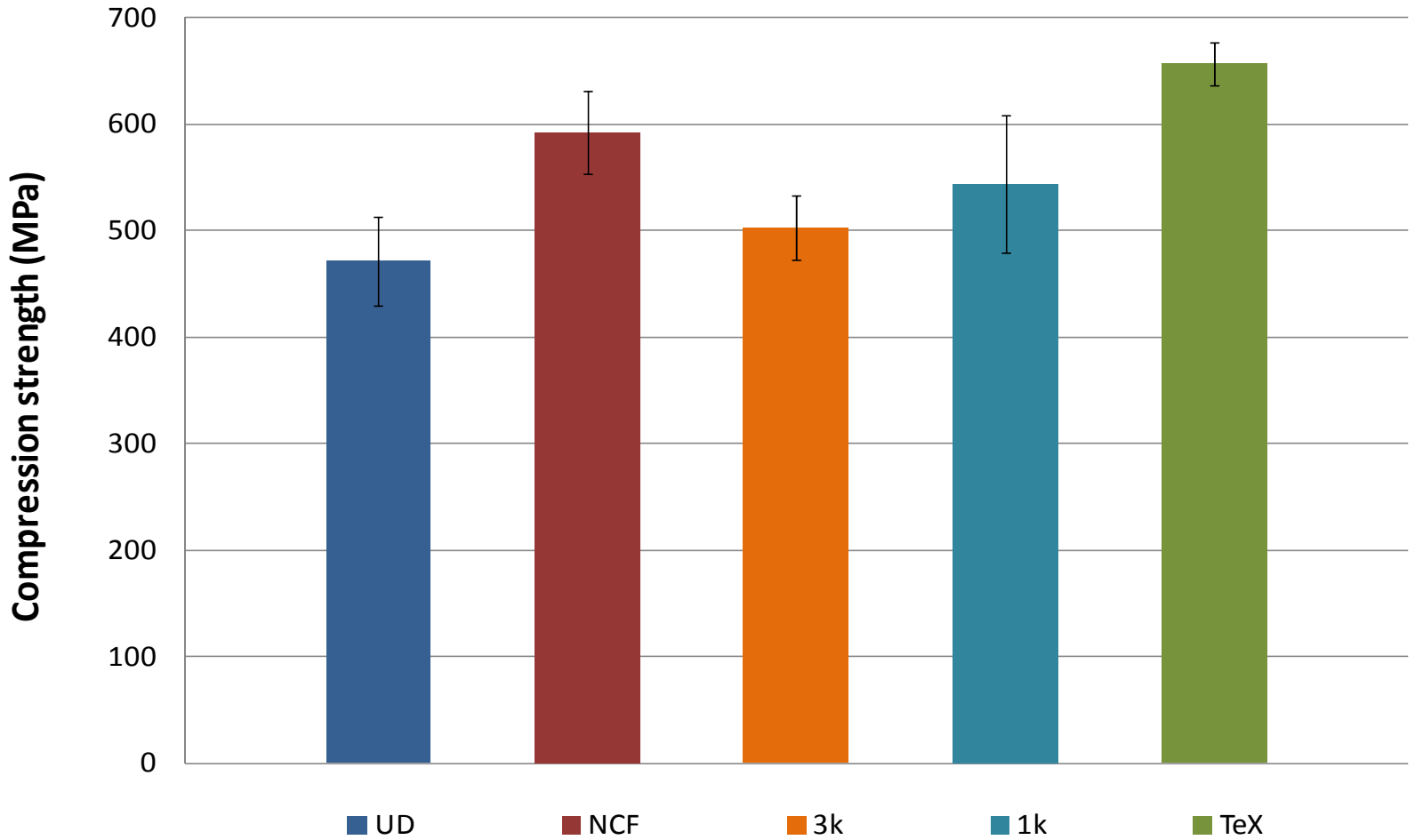
Compression strength (MPa)
700
600
500
400
300
200
100
0
UD
NCF
3k
1k
TeX

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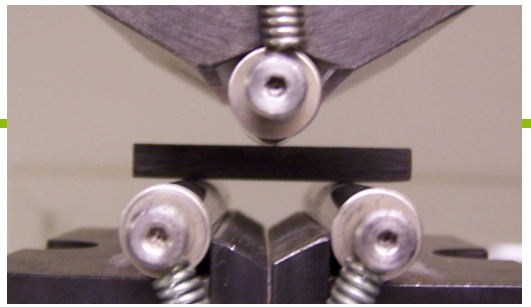

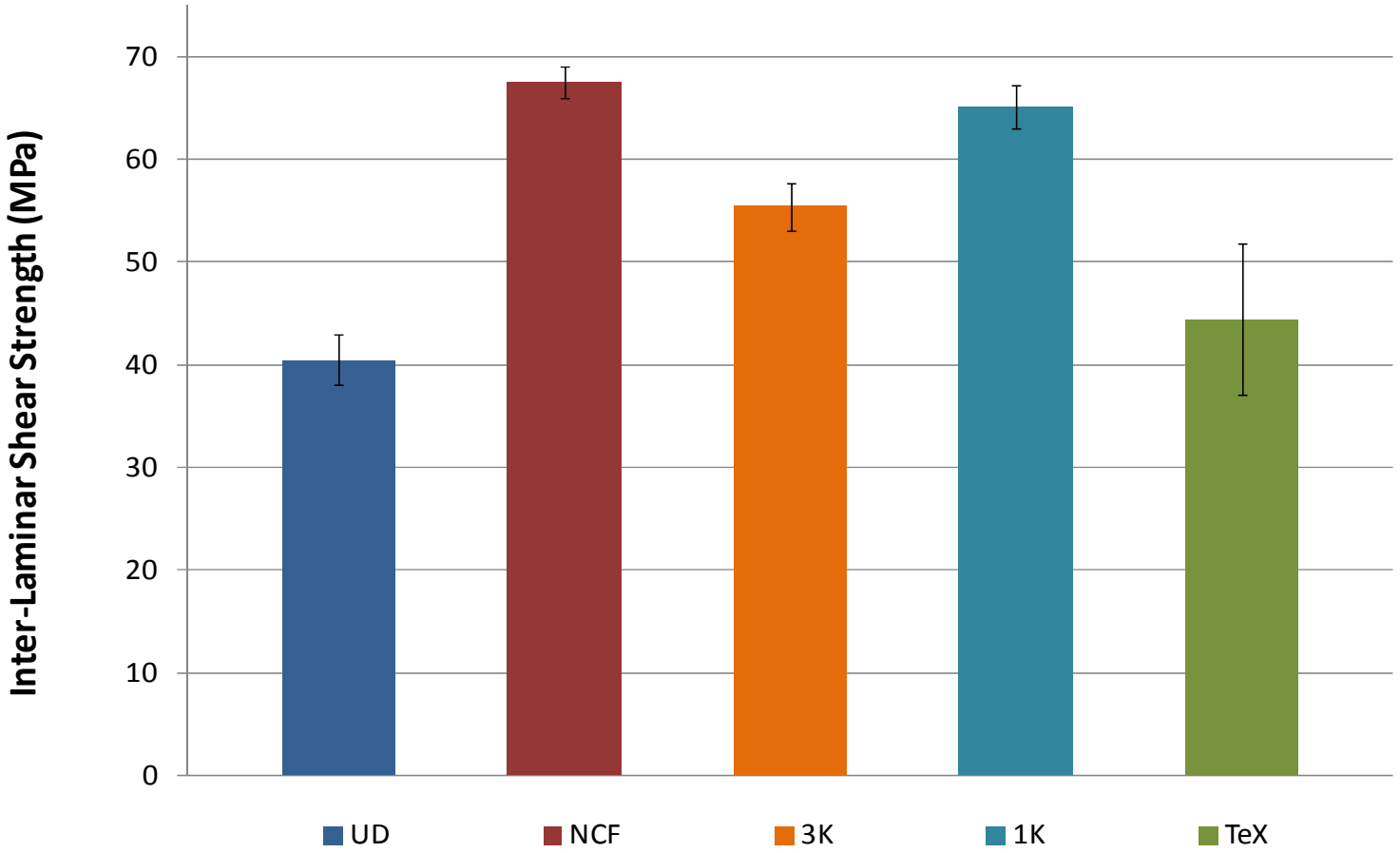
Inter-Laminar Shear Strength (MPa)
70
60
50
40
30
20
10
0
UD
NCF
3K
1K
TeX

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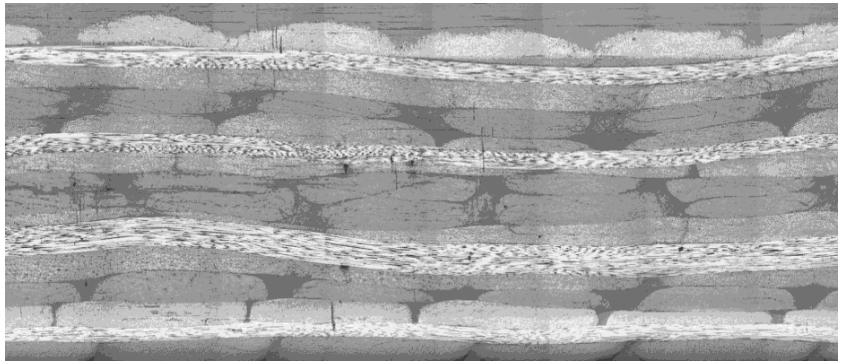
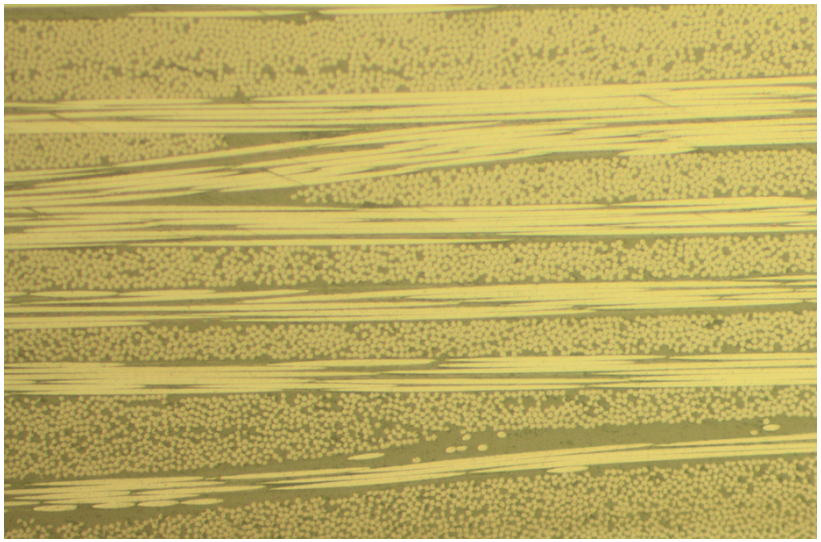
Limited nesting gives low ILSS for TeXtreme®



NCF



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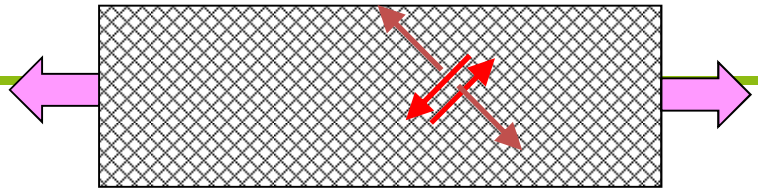

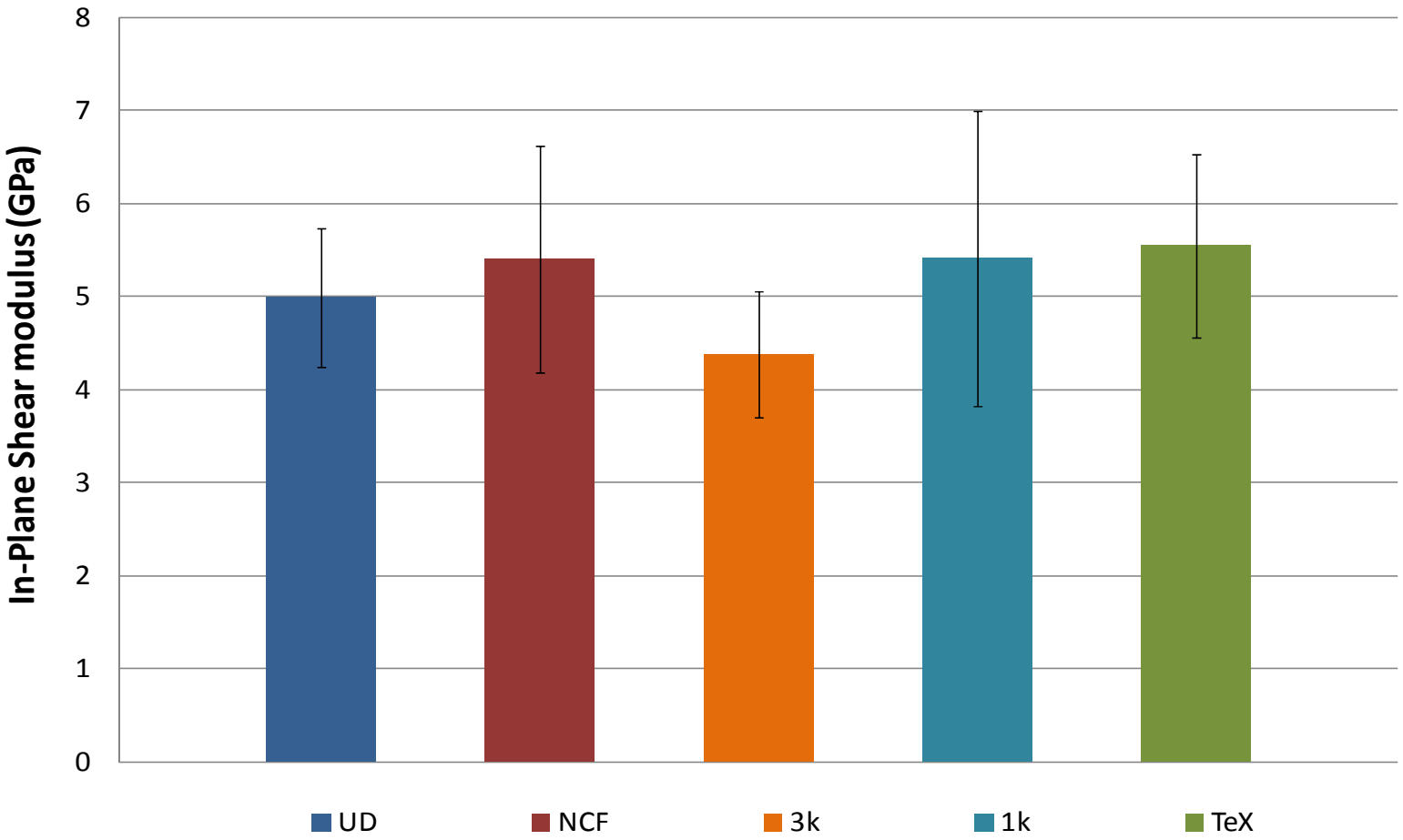

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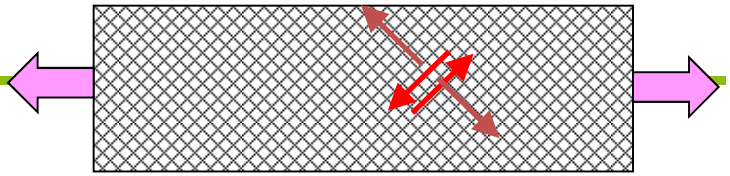

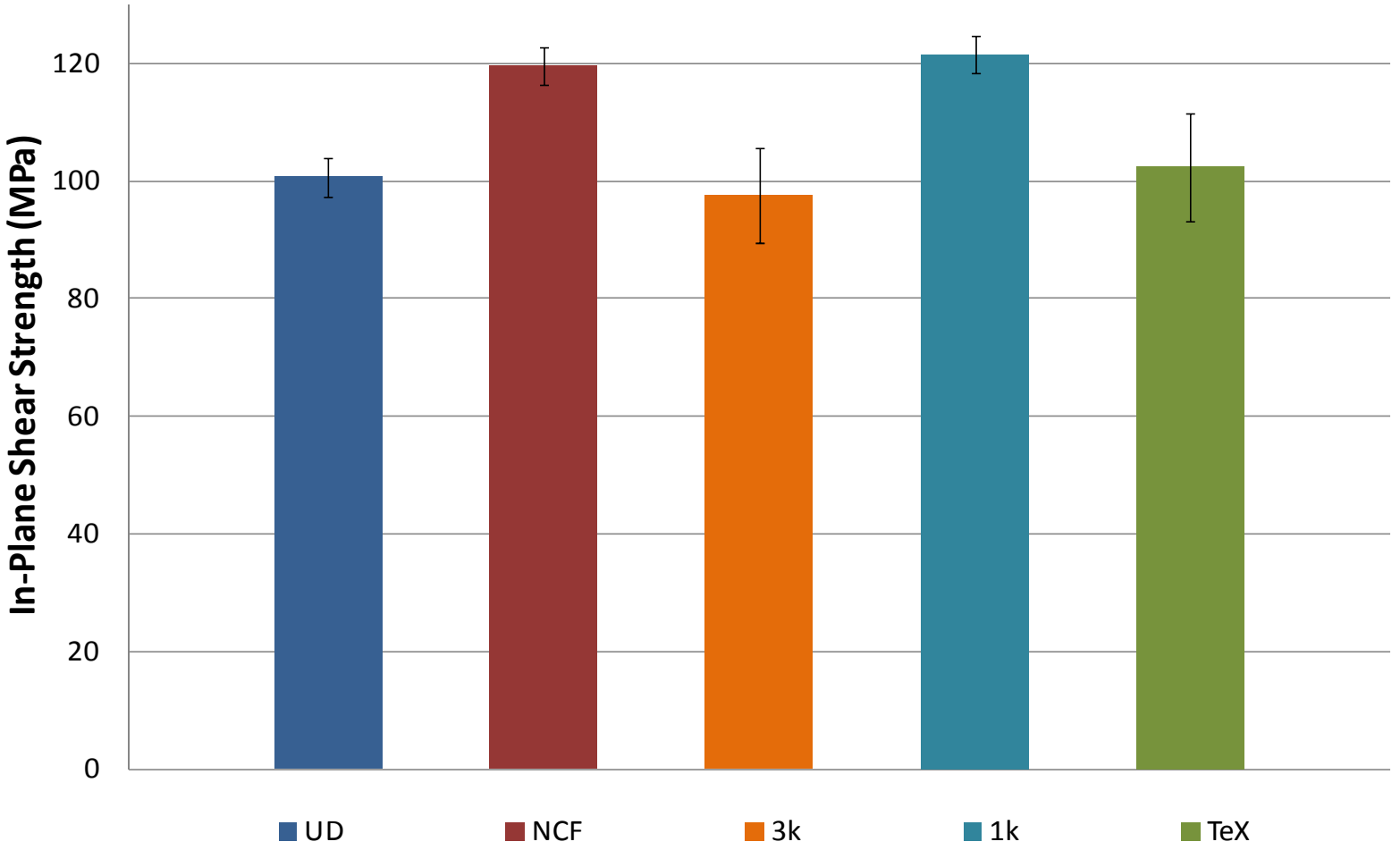
In-Plane Shear Strength (MPa)
120
100
80
60
40
20
0
UD
NCF
3k
1k
TeX

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Summary – Mechanical performance

TeXtreme laminates compared to other reinforcements performs better:

- in tension (reinforcement dominated property)
- in compression (affected by both matrix and reinforcement)

TeXtreme laminates are on par with other reinforcements in:

- In Plane Shear (matrix dominated property)

TeXtreme laminates are inferior to other reinforcements in:

- Interlaminar shear (matrix dominated property)

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RVE – band weave fabrics

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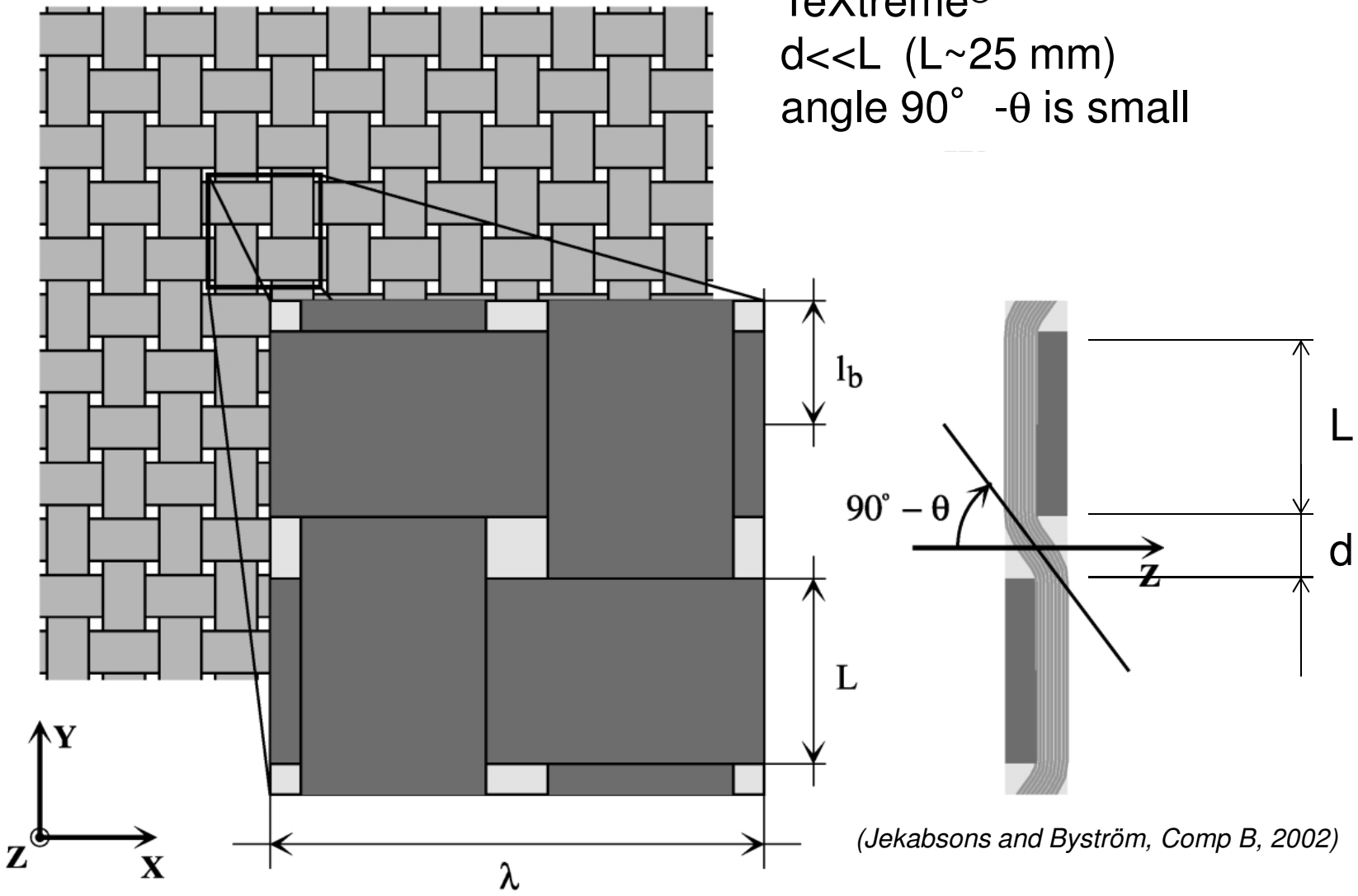
d<<L (L~25 mm)
angle 90° -θ is small



(Jekabsons and Byström, Comp B, 2002)

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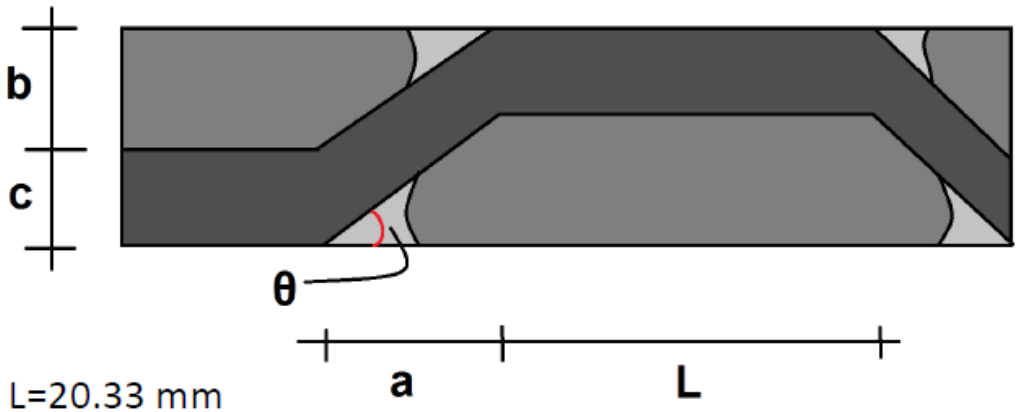
The proposed approach

Oxeon Spread tow weave -Measurements



L=20.33 mm
a=1729,37 µm
c=70 µm
θ=2.56

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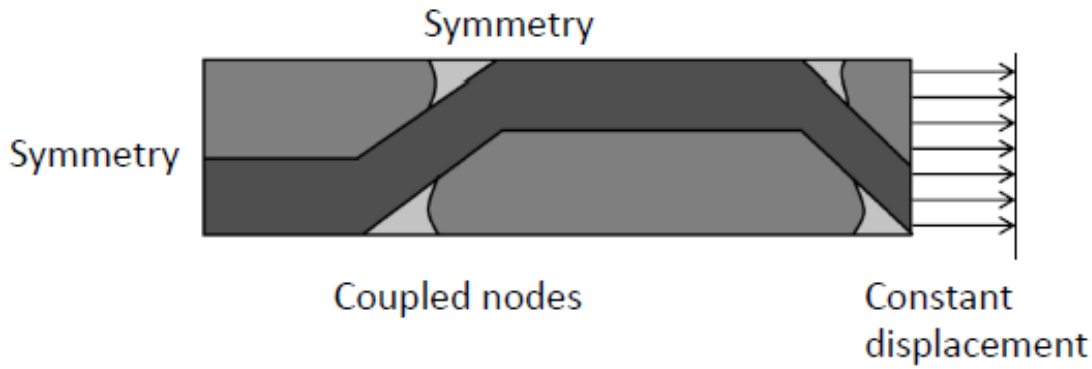
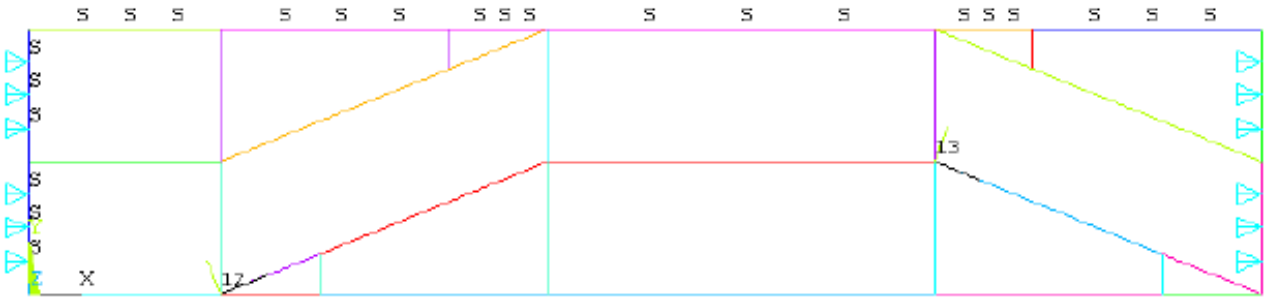
Example: in-plane stiffness





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Stiffness knock-down in TeXtreme®

Stiffness knock-down

Stiffness knock-down

$\eta = E_1 / E_0$

η= 99.92 %

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Shark Aero

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Bauer Hockey

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Bicycle (Felt, PRO, Switch)

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Boards & More

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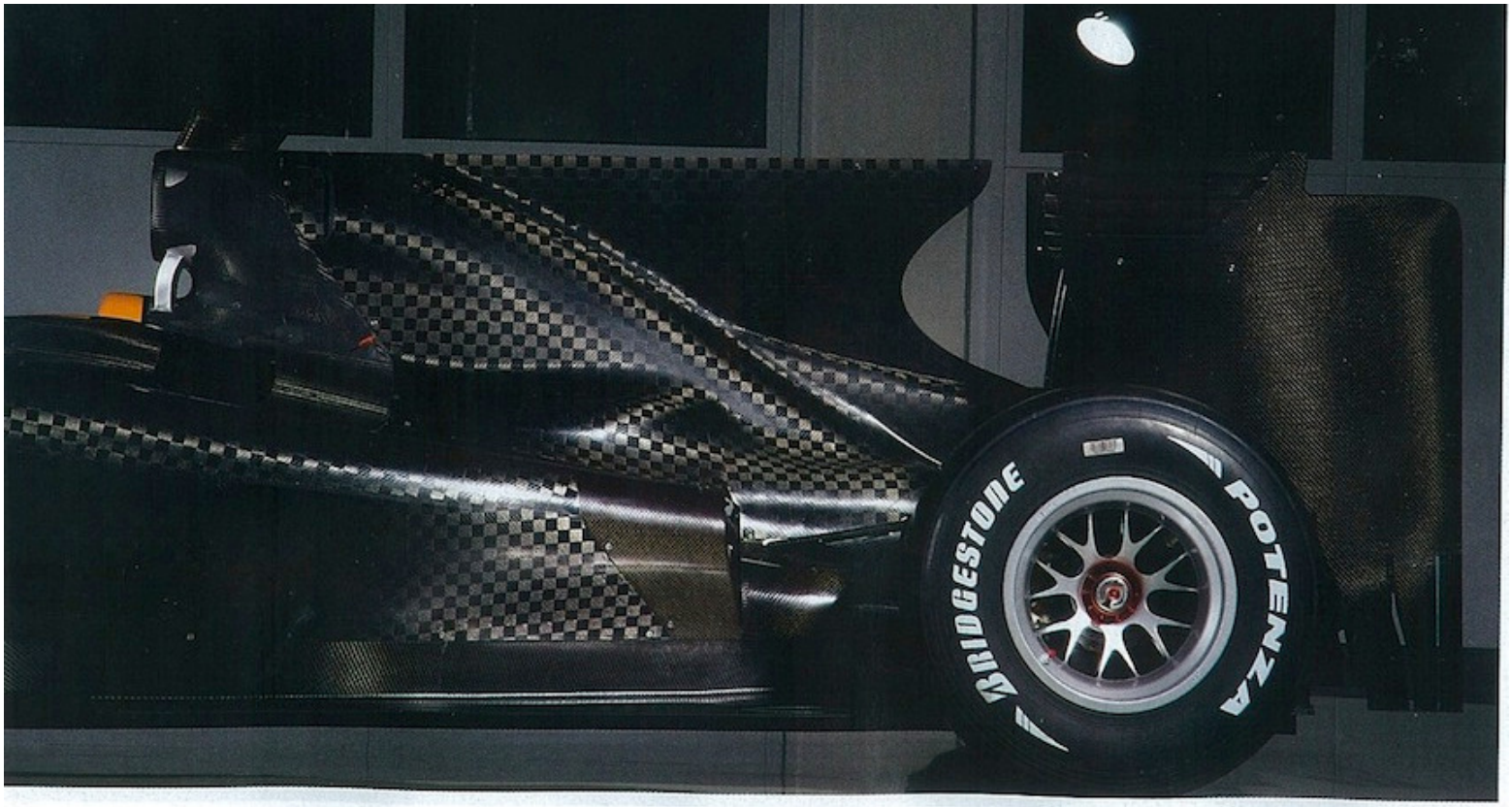
Formula 1

TeXtreme®

Formula 1



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Baltic Yachts

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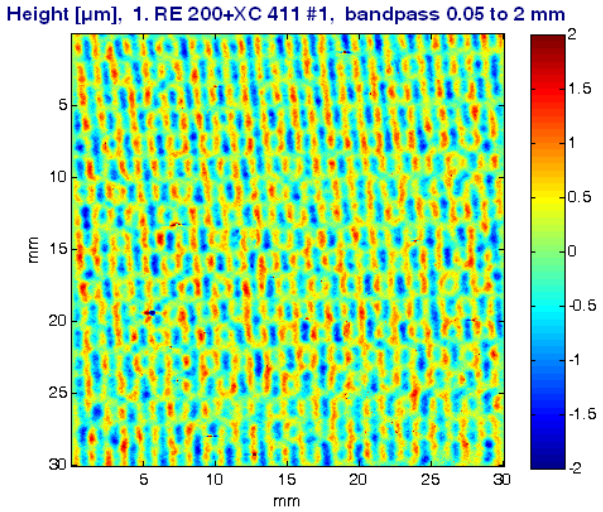
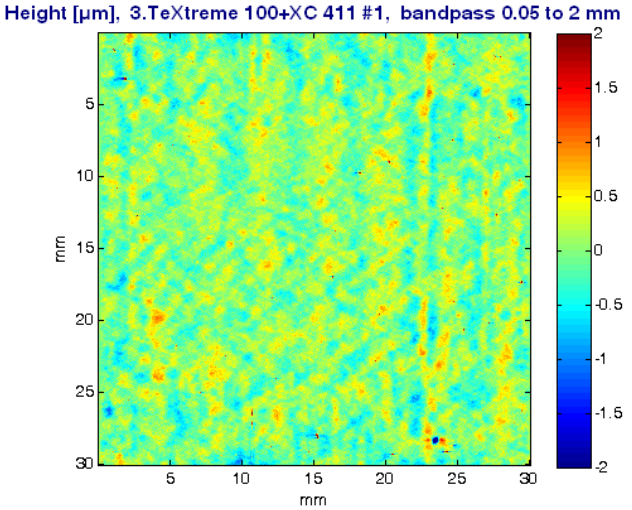
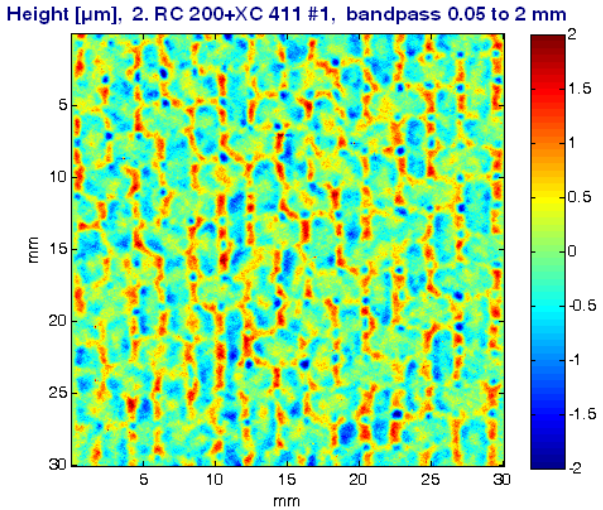
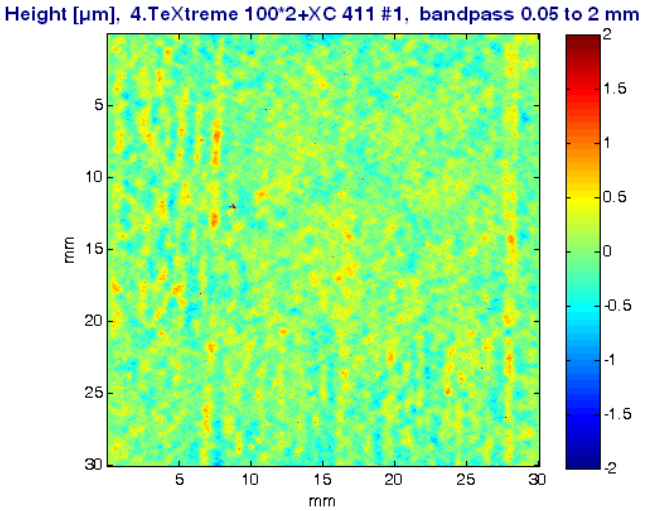
OptiTopo









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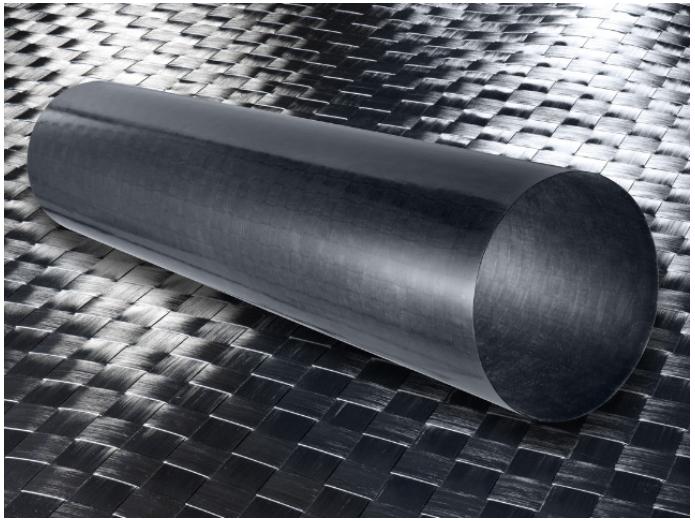
Thermoplastic



Used in the Bamboo concept car

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Design Methodology Project

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FOR SUSTAINABLE GROWTH

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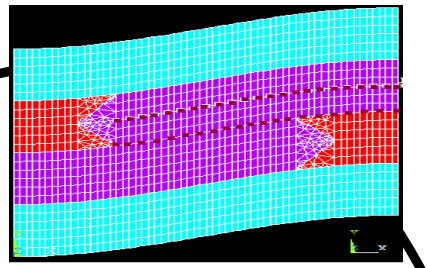
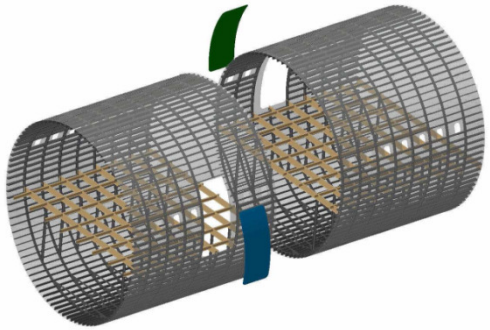
Material models



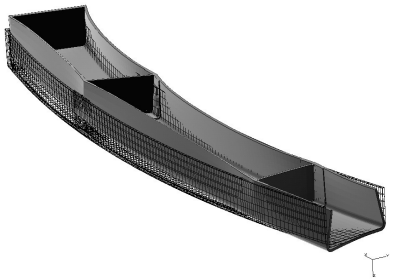
Structural Mechanics

Component and Structure



Process Knowledge

Shape distortions and Residual stresses



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