Natural fiber composites for space applications

Clean Space industrial days, 25.10.2017

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Play naturally smart

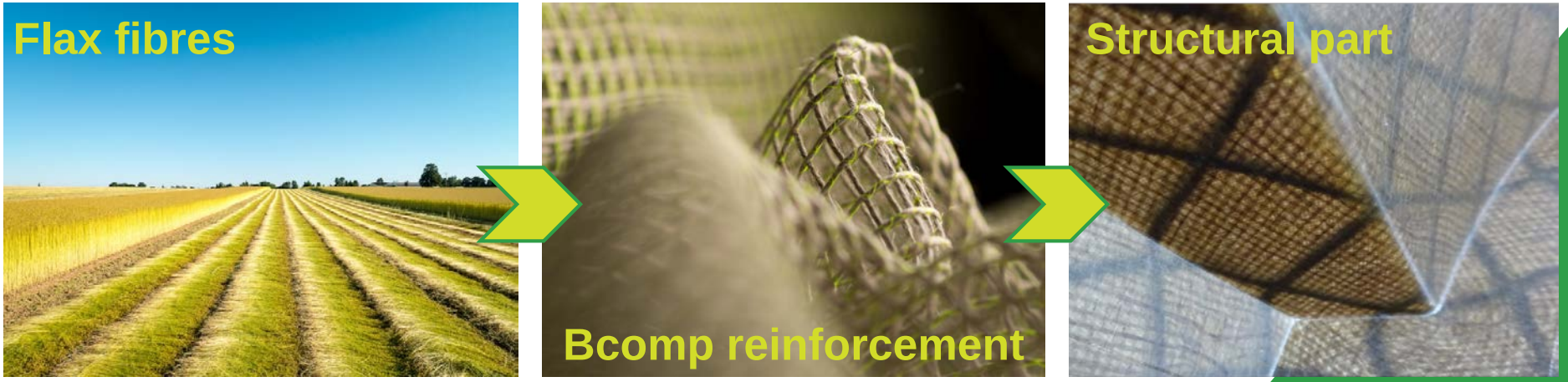
ABOUT BCOMP

- Founded 2011, 12 Employees
- Several innovation- and start-up awards, including Swiss Economic Award 2016
- Broad customer basis in Sports & Leisure and Luxury industries (e.g. K2, Black Diamond, Nordica, Stöckli, Starboard)
- Lightweighting development projects with leading Automotive OEMs
- International academic/research network

OUR VALUE PROPOSITION

We deliver **lightweight, high-performance materials** in a renewable package

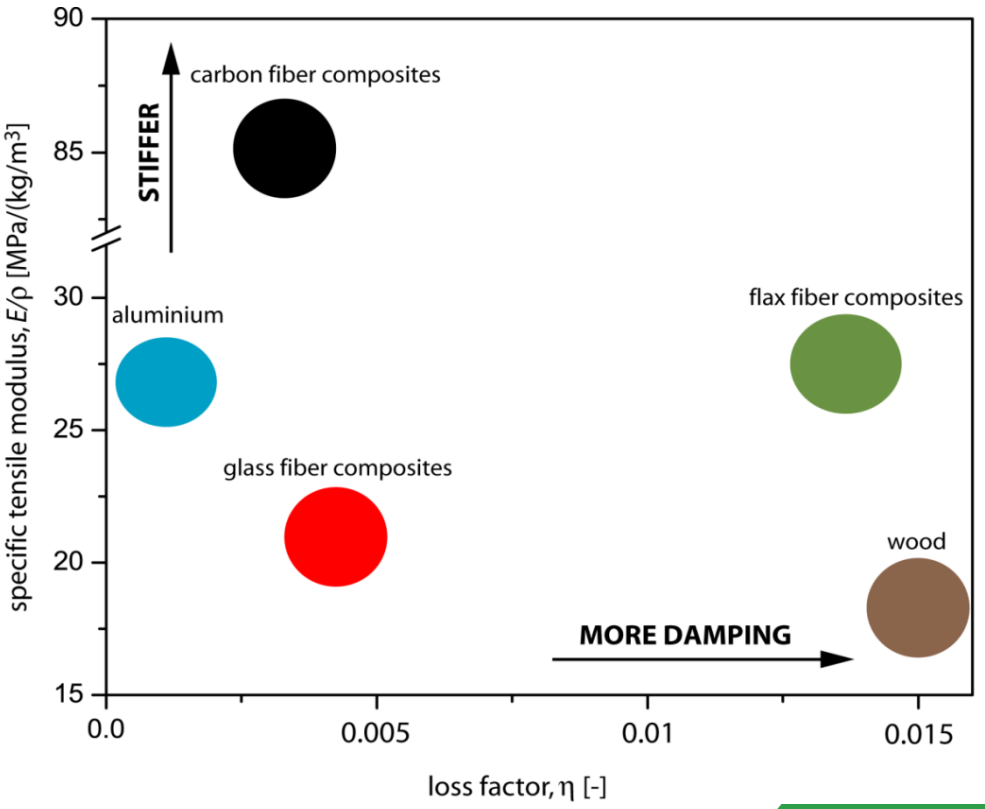
- **Weight reduction** of up to **40%**
- **Material cost reduction** of up to **30%**



BCOMP PRODUCT PORTFOLIO

Why using natural fibers?

- High specific stiffness
- Good vibration damping properties
- Probably demisable
- Radio-transparent
- Sustainable fibers



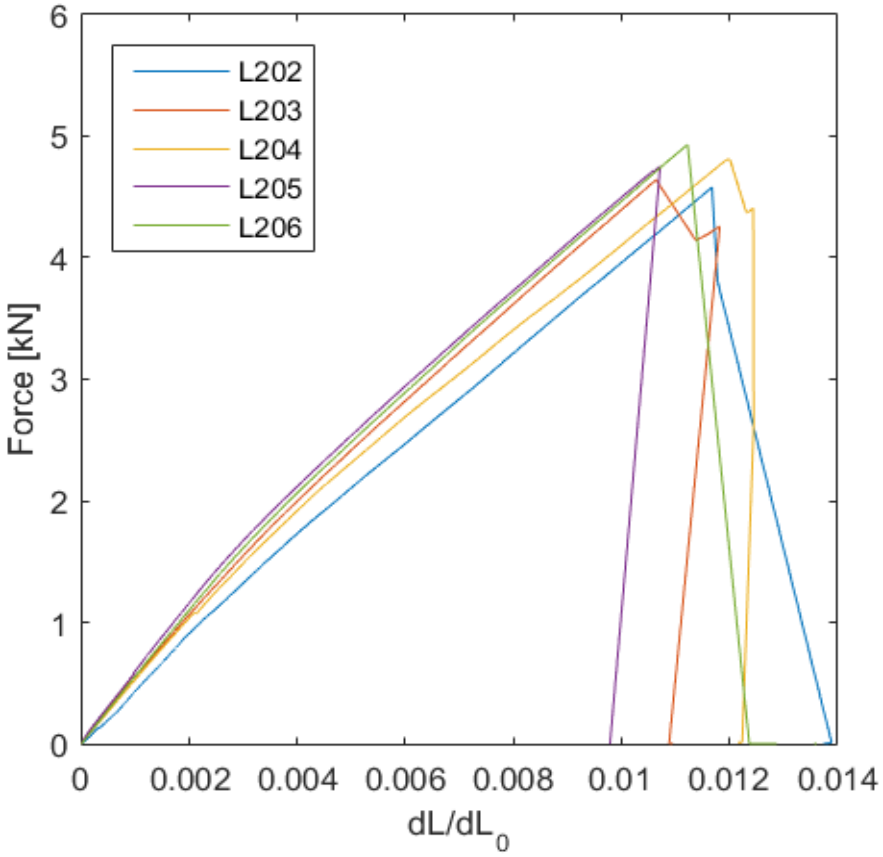
State of the art for space applications

Are natural fibers applicable for space?

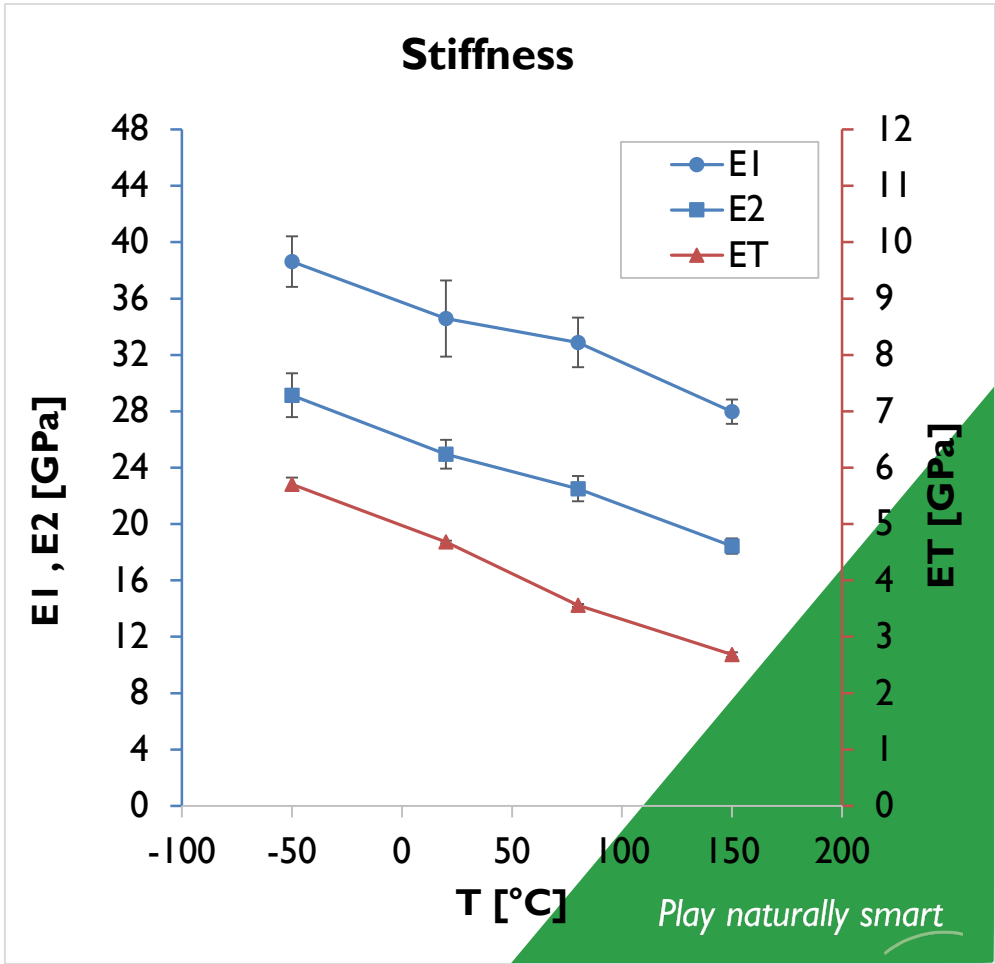
- Tensiles tests between -50 and 150° C
- DMA tests from -150° C to 150° C
- TMA tests
- Outgasing tests
- Moisture tests

Tensile tests

- Bilinear behaviour



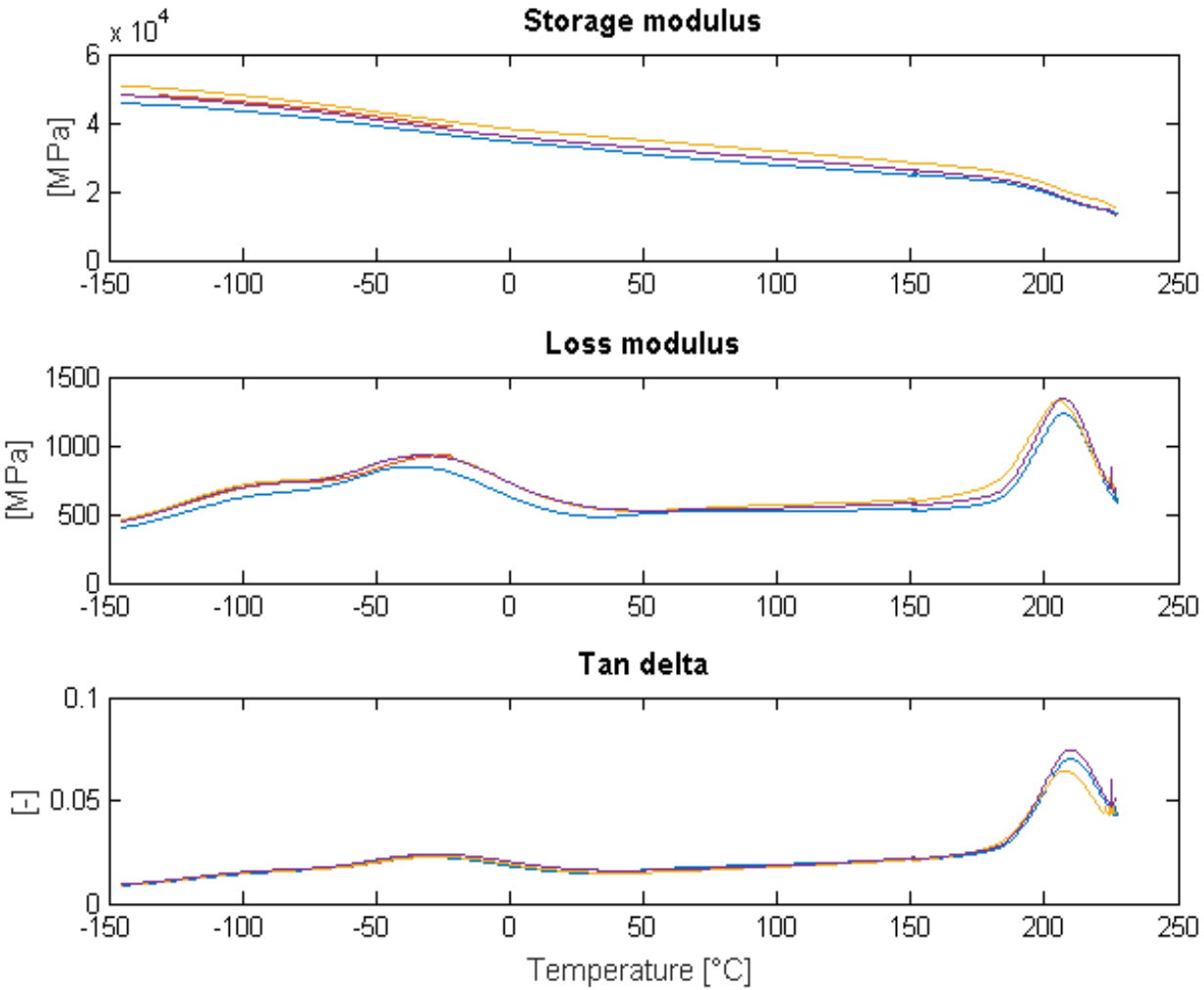
- High specific stiffness at low temperature
- Loss of stiffness with temperature increase



DMA tests

Test on L specimens:

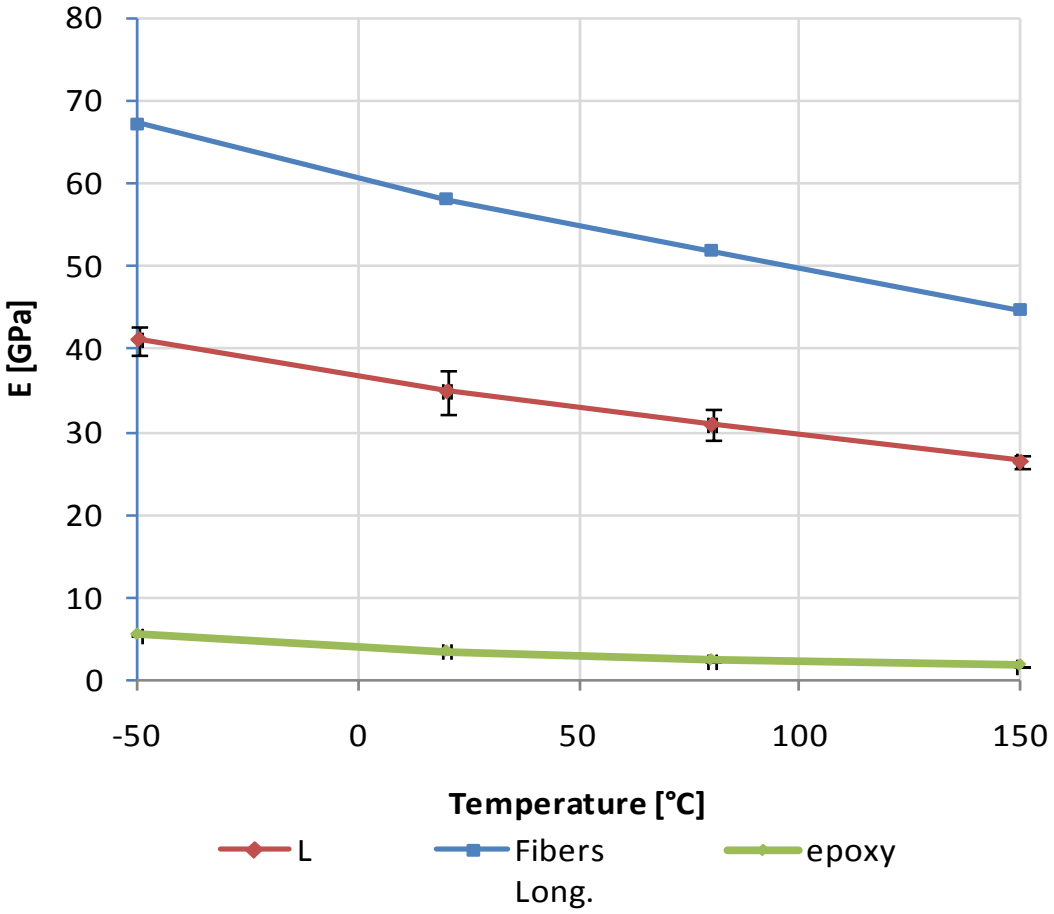
- Constant decrease of E with T increase
- Damping quite constant



DMA tests

E-modulus:

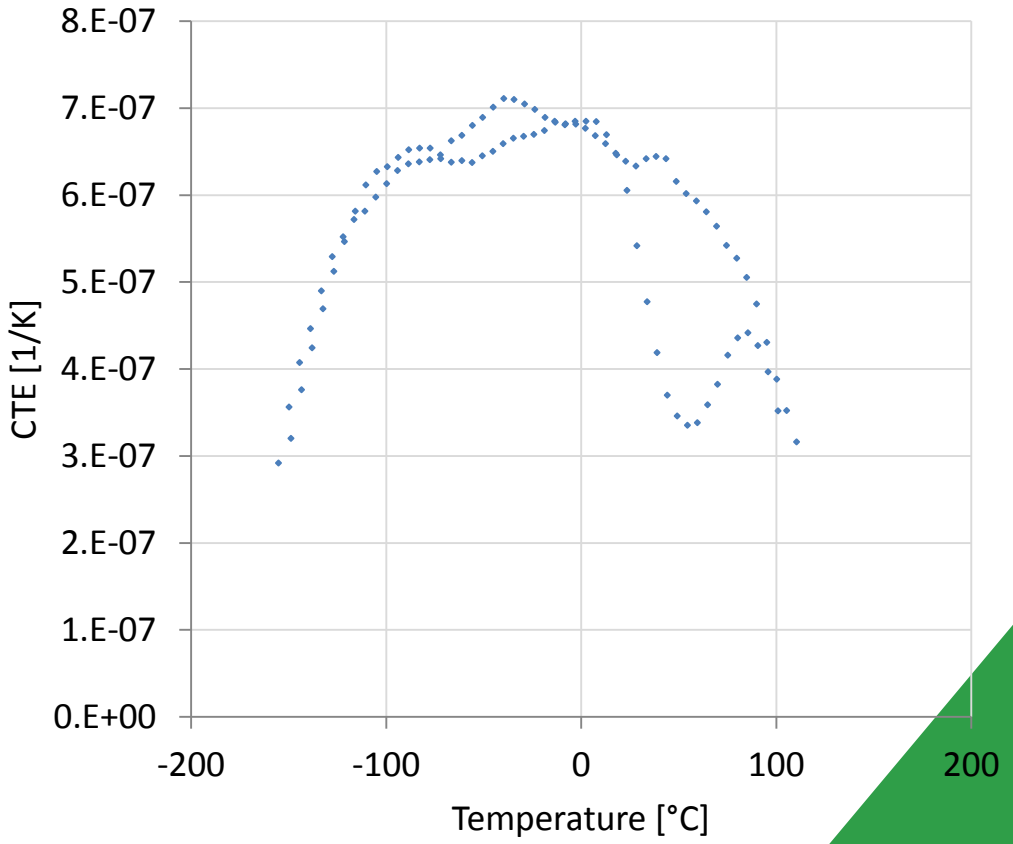
- Constant decrease of E with T increase
- Decrease of E both on epoxy and on pure flax fibers



TMA tests

- Near 0 CTE in L direction
  - Good compatibility with carbon fibers
- CTE in transverse direction similar to epoxy

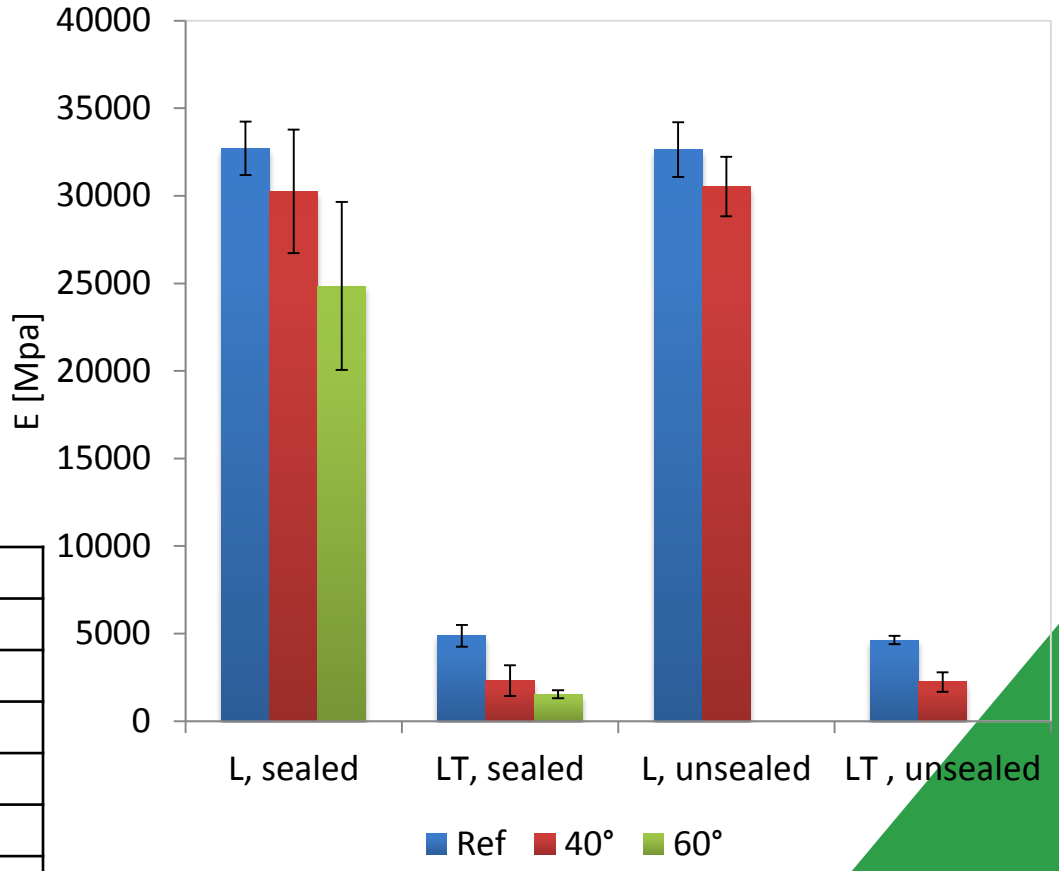
T [°C]	CTE [1/k]
-50	6.00E-07
20	6.16E-07
80	3.89E-07
120	2.53E-07



Moisture tests

- Aging at 40° C (250h) and 60° C (250h), 100% humidity, temperature cycles
- Loss of modulus and strength with aging in moisture, both L an LT
- No effect of thin epoxy sealing

Aging	Type		Strength	E
40°C	sealed	L	84%	92%
		LT	70%	48%
	unsealed	L	86%	94%
		LT	72%	48%
60°C	sealed	L	75%	76%
		LT	69%	31%

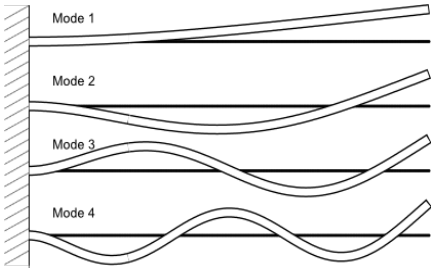


Outgasing tests

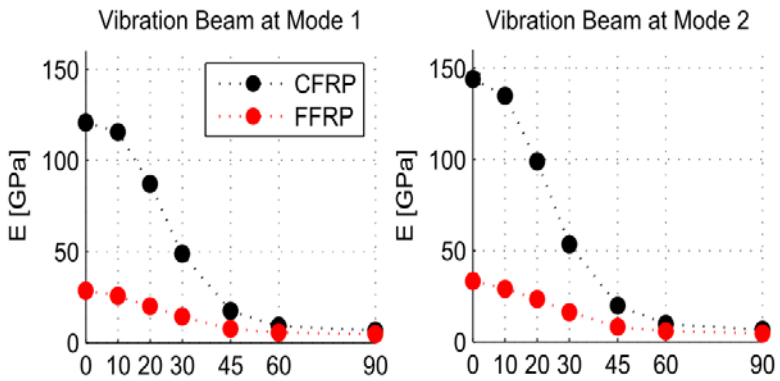
- Materials:
  - Flax UD + epoxy
  - Pure flax fibers
  - Sample size: 1g of each (later divided in 3)
- Test following ECSS-Q-70-02
- Outgassing levels good except for water

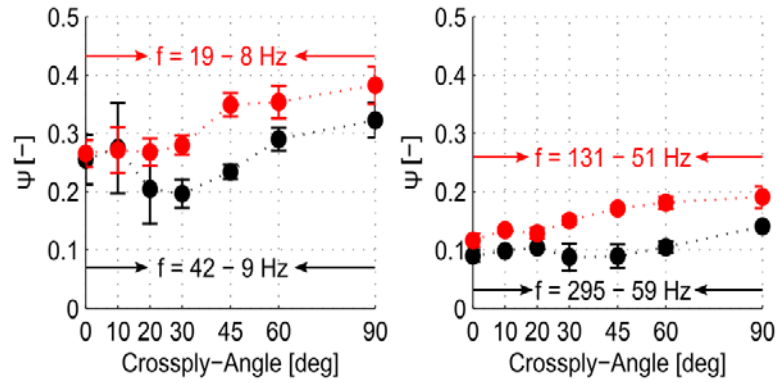
Flax composite	TML:	1,40	RML:	0,80	CVCM:	0,01
Flax fabric	TML:	4,70	RML:	0,87	CVCM:	0,08

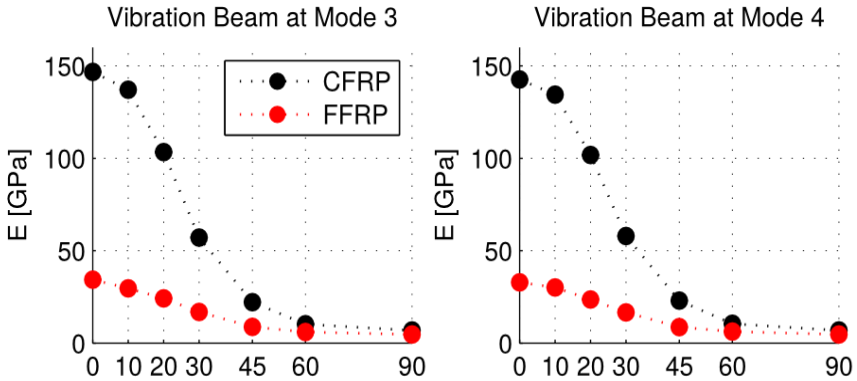
Vibrations damping

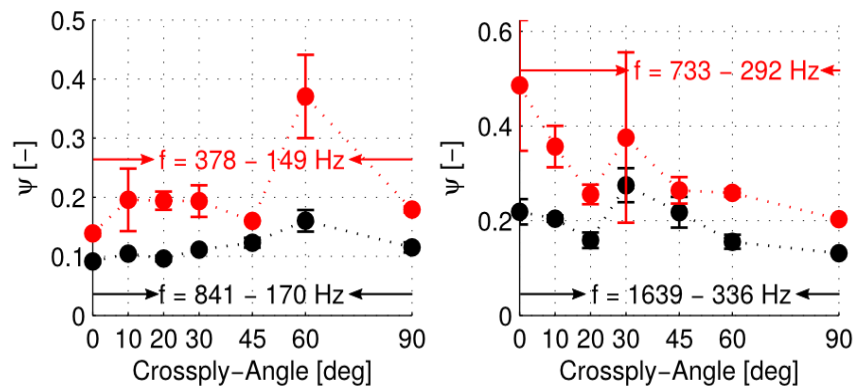


- Measurements of damping on UD samples with various fiber angles









Limitation of natural fibers

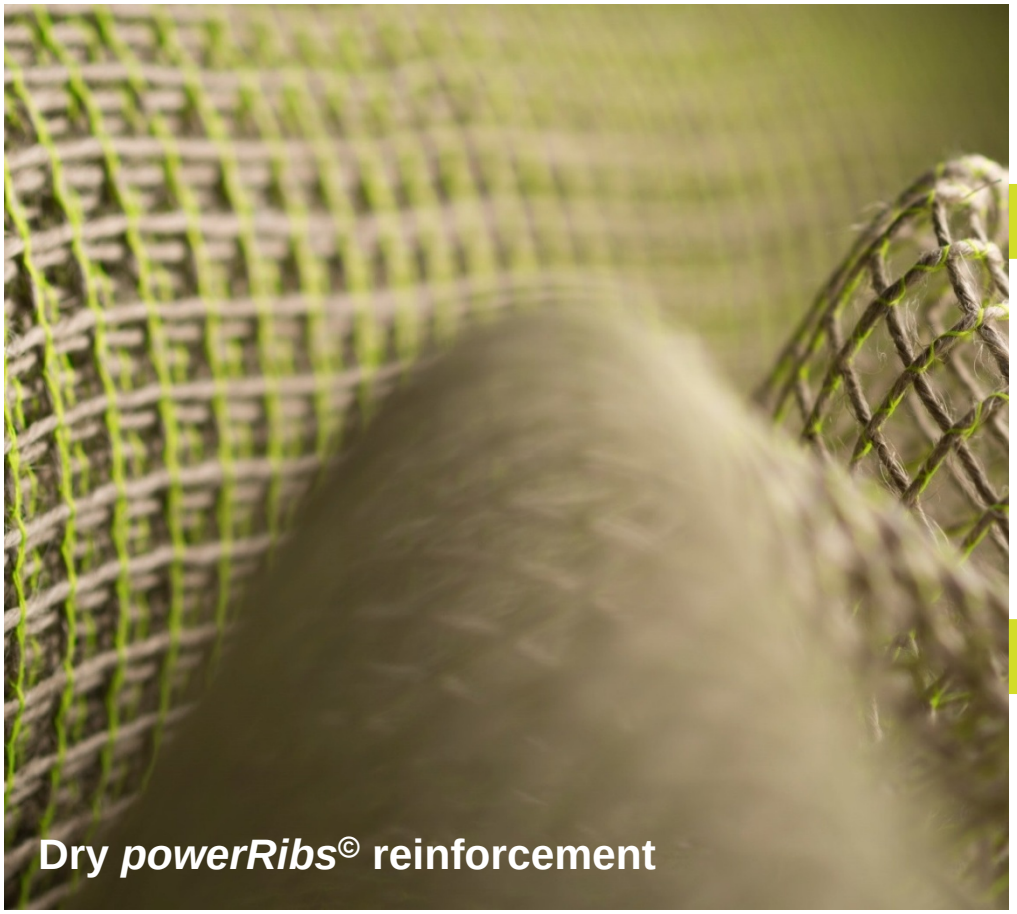
- E-modulus limited compared to carbon fibers
- Limited strength (~300 MPa for the composite)
- Environmental resistance: sensitive to moisture, edge coating mandatory

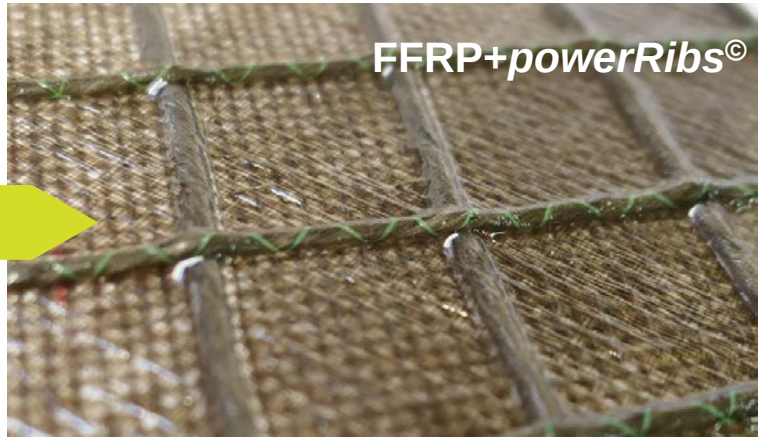
Natural fibers applicable for space, but with limited performances

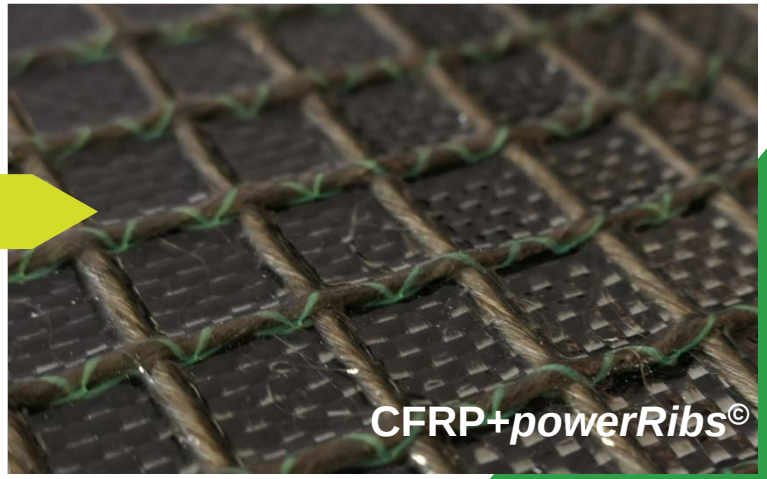
How to overcome these limitations?

powerRibs® – A NOVEL REINFORCEMENT...

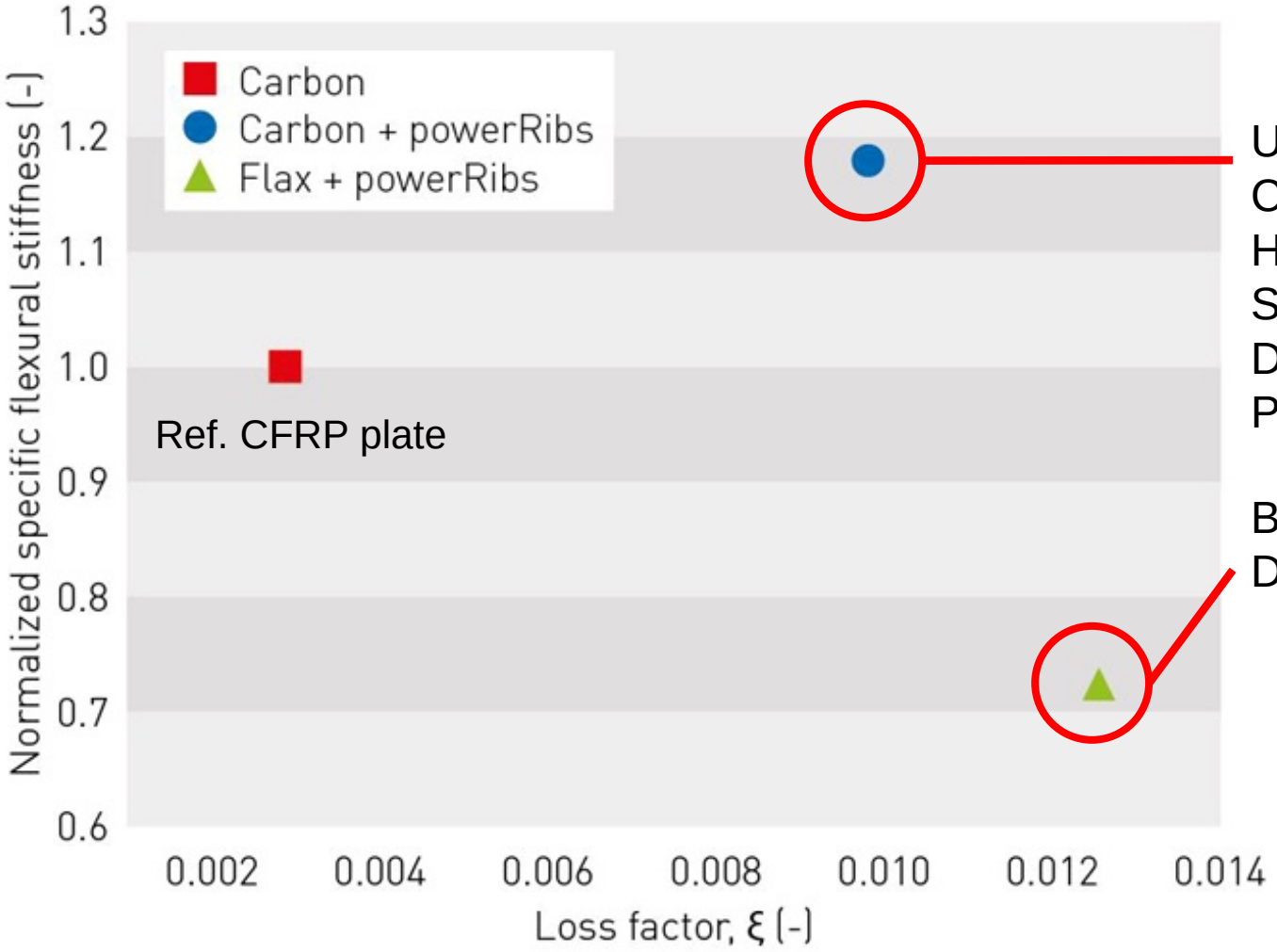
High-performance reinforcement for single-skin composites with a unique performance-price ratio.







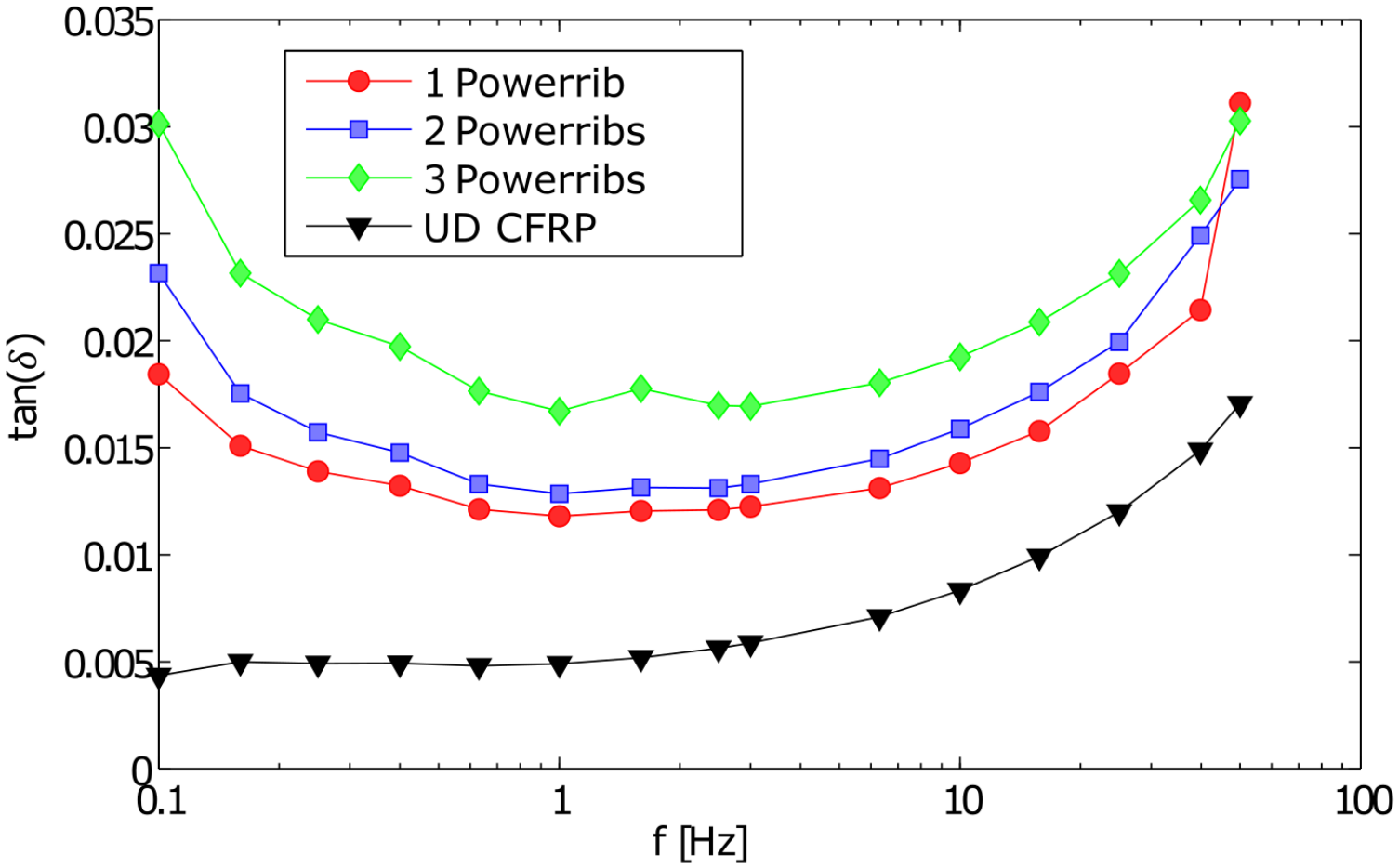
powerRibs® performances



UNIQUE COMBINATION OF HIGH FLEXURAL STIFFNESS AND DAMPING PROPERTIES

BIO-COMPOSITE, DEMISABLE?

powerRibs® damping



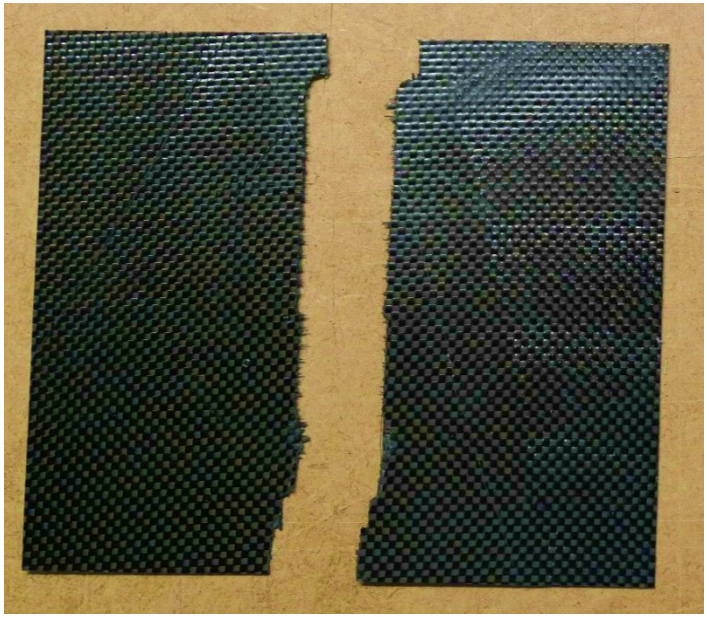
Example: powerRibs® for motorsports

- Lighter
- Lower cost
- Stiffer & stronger
- Better impact- and crash behavior
- Less consumables and easy processing

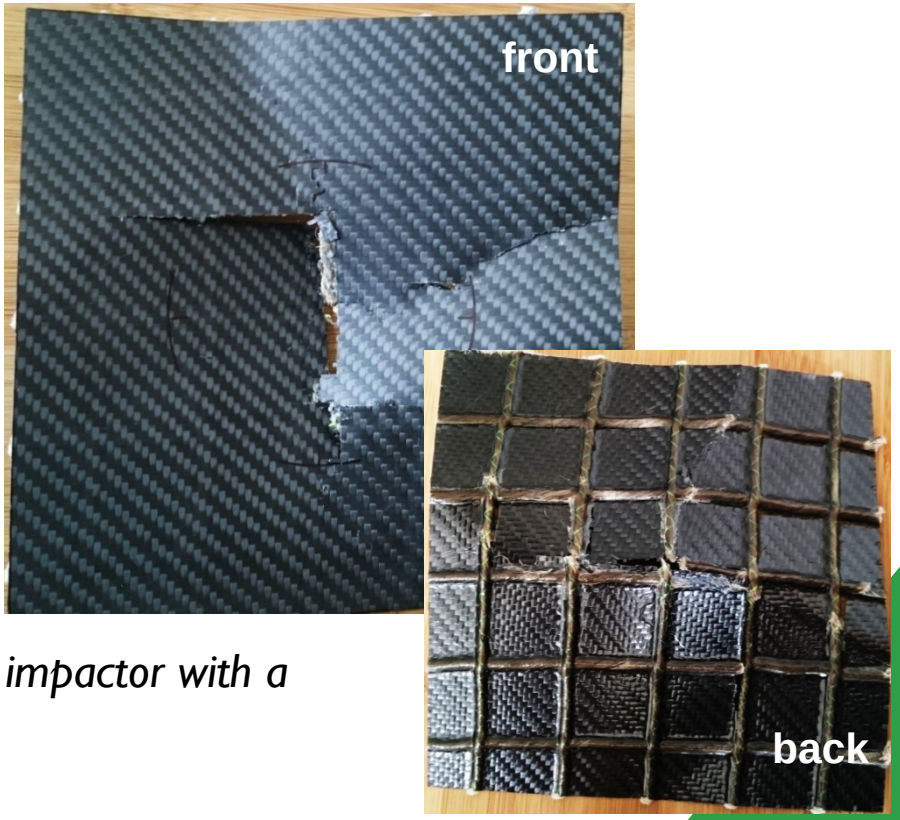
*TESLA-based Electric GT car: hood and roof featuring FFRP+**powerRibs©** composites*

powerRibs® better impact behaviour

600 gsm carbon fibres



240 gsm carbon fibres +
220 gsm ***powerRibs***®



Impacted from 2m with a bullet shaped impactor with a radius of 50mm and a mass of 2.5kg

powerRibs® better impact behaviour

carbon fibres

carbon fibres + *powerRibs*®

Conclusions

- First test series have shown that flax fiber composites are applicable for space. However more tests are still required:
  - Fatigue (mechanical and thermal) and creep
  - UV resistance
  - Radio-transaprency
  - Demisability
  - Moisture resistance with better coating
  - …
- Performances of flax fiber composites are limited compared to carbon fiber. The use of ***powerRibs***® technology allows to compete with carbon fibers for thin shell applications.
- Damping performances of flax is confirmed, and even more pronounced with ***powerRibs***® technology.

Bcomp®

PLEASE CONTACT US FOR MORE INFORMATION

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Bcomp®

Back-up slides

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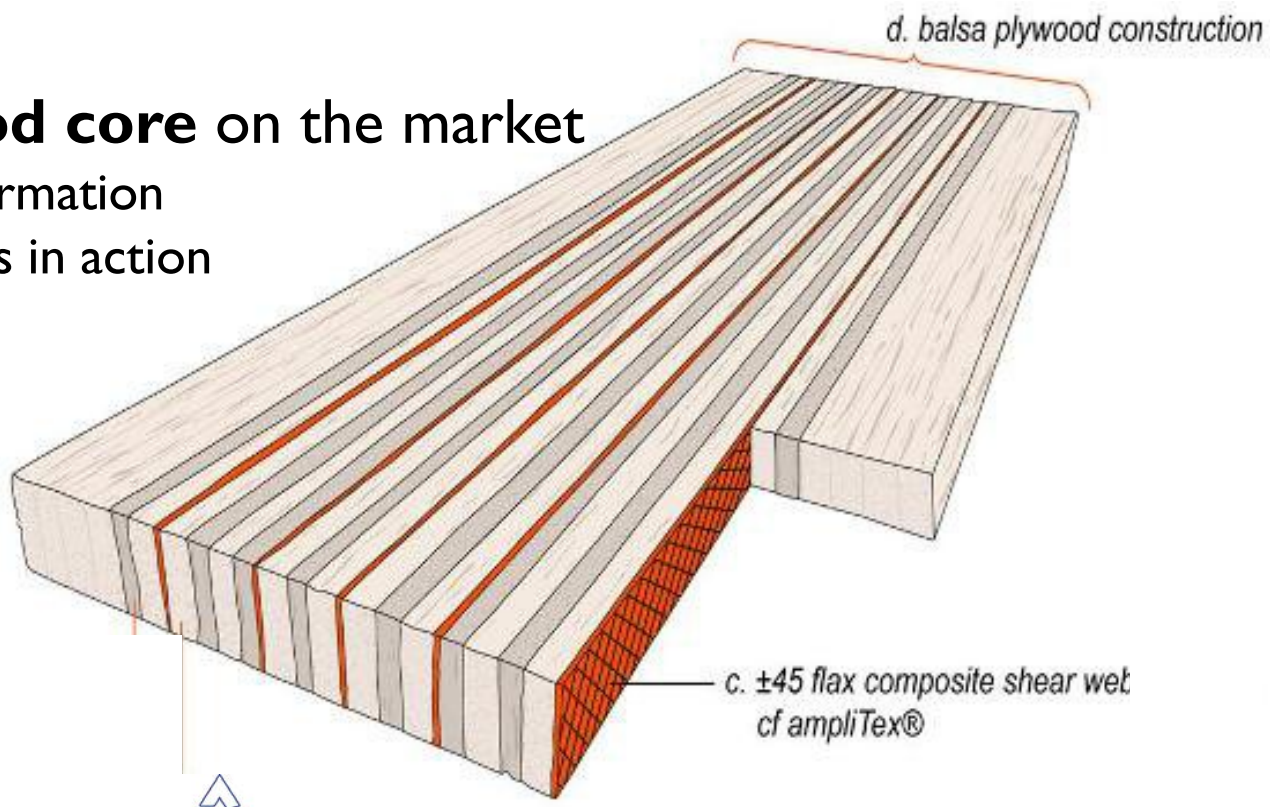
bCores®

The **lightest ski wood core** on the market

- Click here for more information
- Click here to see bCores in action

Candide Thovex in action



K2 SKIS

Black Diamond

STÖCKLI the swiss ski

FACTION

NORDICA

black crows

elan www.elanskis.com

dps

Play naturally smart

Innovative, natural & sustainable top-notch flax fibre fabrics for the next generation composites (click here for more)

ampliTex® CUSTOMER APPLICATIONS


Saddle sheet (developmt. proj.)


Hublot watch casing & display


Blackbird guitar

Timber Sup skate board


dabdesign motorbike body parts

OUTPERFORMING CARBON COMPOSITES

Benchmark 1000 gsm CFRP

Layup	Dry weight [g/m²]	Flexural stiffness	Impact properties	Crash behaviour	Low cost
Full carbon	1000	+++	++	+	+
Full flax+***powerRibs***©	820	+++	++	+++	+++
Carbon-flax+***powerRibs***©	720	+++	+++	++	++

Benchmark 600 gsm CFRP

Layup	Dry weight [g/m²]	Flexural stiffness	Impact properties	Crash behaviour	Low cost
Full carbon	600	+	+	+	+
Full flax+***powerRibs***©	520	+++	++	+++	+++
Carbon+***powerRibs***©	450	+++	+++	+++	++

powerRibs© FOR MOTORSPORTS - SUMMARY

Product description

- Full flax + ***powerRibs***©
- Flax-carbon + ***powerRibs***©
- Dry for infusion or prepreg

Processing

- Prepreg processing movie
- Infusion processing movie

Applications

Single-skin composite parts designed for flexural stiffness and optimum crash properties, such as hood, roof, front- and rear wings, front- and rear bumper etc.

powerRibs© FOR AUTOMOTIV INTERIOR

Product description

- powerRibs-PP semi-finished product
- Can be combined with any type of non-woven-PP product for significant weightsaving
- Possibility to integrate visual surface in 1-step process

Processing

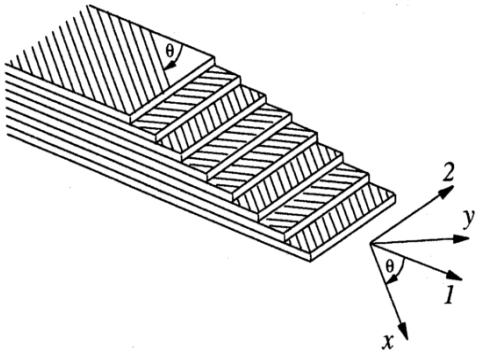
Compression molding movie

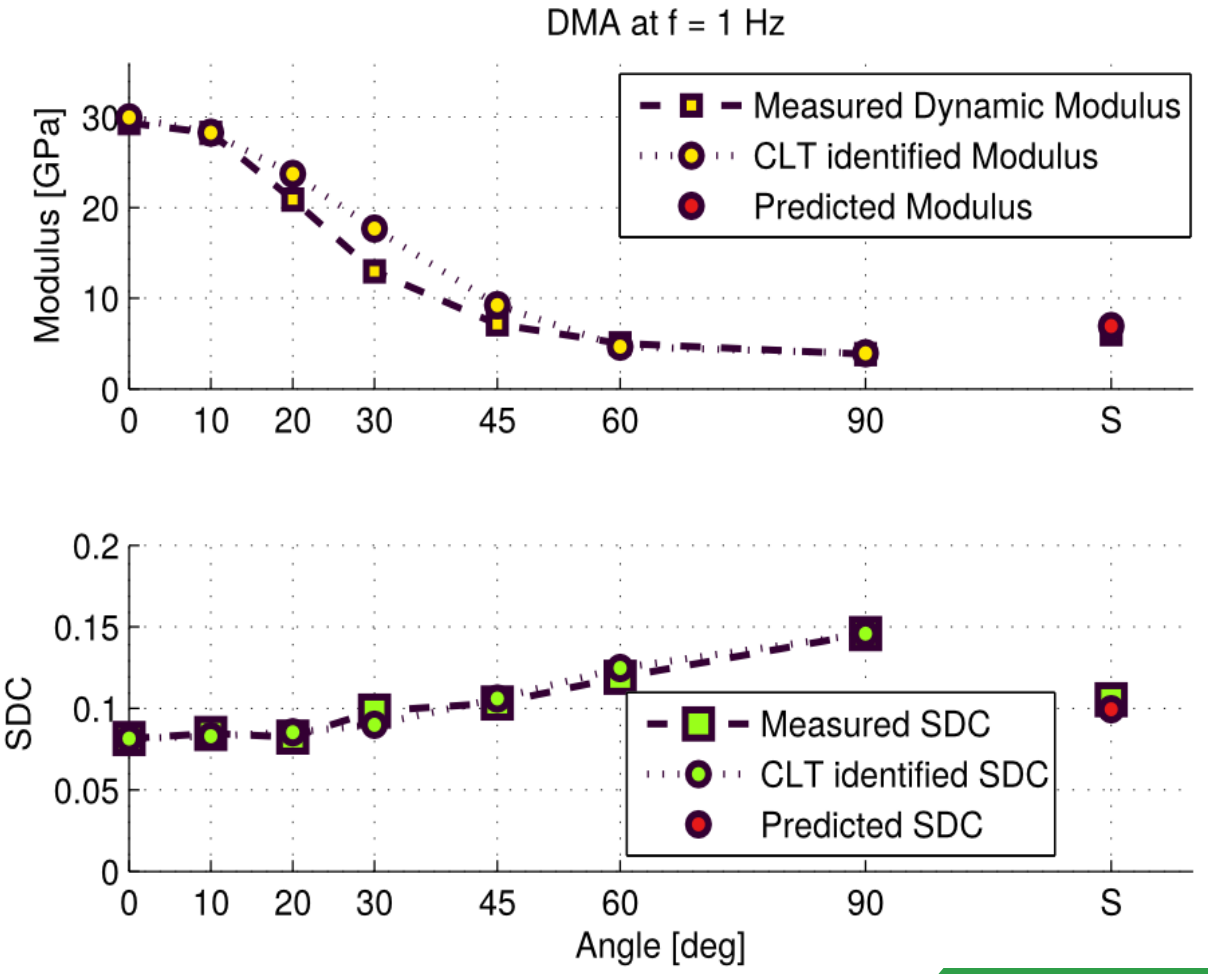
Applications

Interior automotive trim parts, such as door- and front panels, seat back panels, trunk trim etc.

Identification-Prediction of damping

- Flax laminate [S] with layup:
- [-45,60,90,-45]s

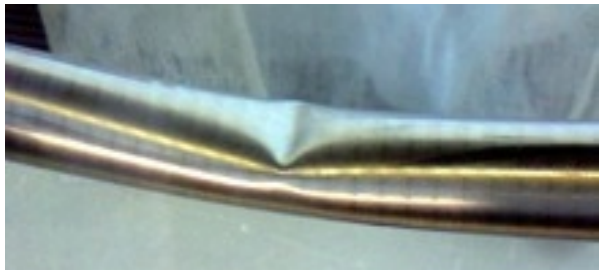




Fundamental problem

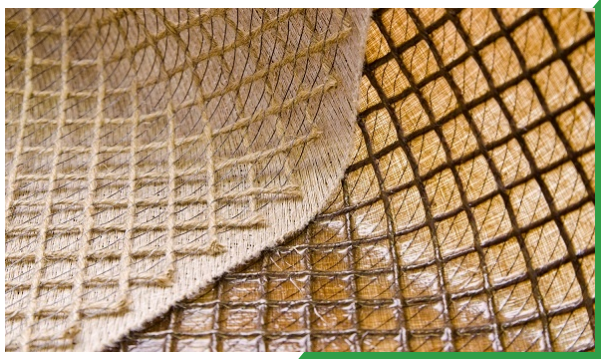
Thin wall composites very sensitive to local compression and buckling

- Parts globally overdesigned and heavier

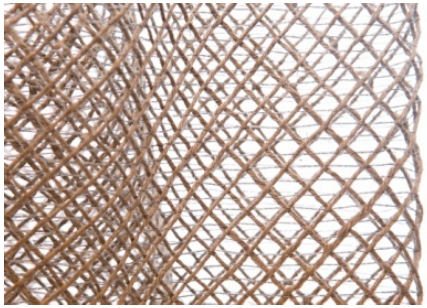


Strategies against local buckling

- Sandwich structures → Complex, expensive, not possible for very thin walls
- Ribs reinforcements → Time consuming to create the ribs
- PowerRibs technology → Easy and cheap to apply, high damping



powerRibs Patented Technology



ampliTex® powerRibs flax fibre fabric

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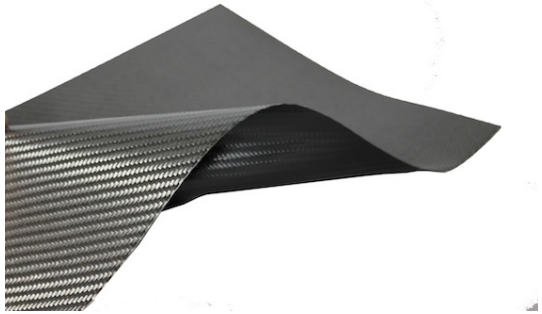

flax/glass/carbon fibre fabric/prepregs

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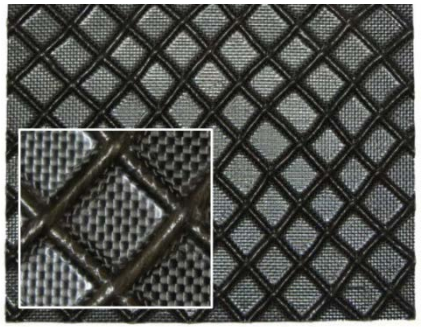

ribbed surface on composite laminates

A mesh of mm-thick flax fibre yarn to readily create a **ribbed surface** in **open mould processes** :

- Passive surface approach to increasing flexural moment and damping
- Can be tailored in yarn weight, mesh spacing (mm-range) and orientation (0° /90° , □45°)
- Optimized twist to prevent flattening during processing while preserving most of the yarn's stiffness

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