

Development and Commercialisation of High Performance Flax Composites

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BioFibe
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NetComposites

■ Information

- Worldwide News
- Portal for Composite Materials

■ Store

- Books, DVDs, Software, Reports
- Gifts & Products

■ Knowledge Transfer

- Consultancy: Markets and Technologies
- Associations & Networks
- Events & Training

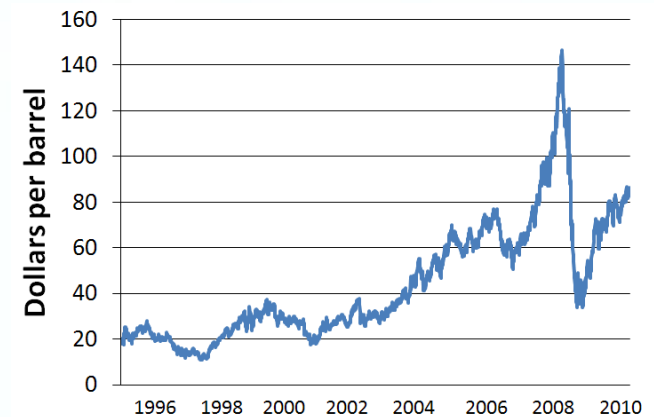
■ Technology

- Research, Development & Commercialisation
- Consultancy: Product Design & Development
- Prototyping & Testing



Biocomposites

- Composites made from all or part natural, renewable materials:
 - Natural fibres (flax, hemp etc.)
 - Bioresins (starch, sugar, crop oils)
- Environmental benefits
 - Reduced CO₂
 - Sustainable resources
 - Biodegradability/compostability
- Other benefits
 - Lightweight
 - Low raw material cost
 - Reduced energy use/cost
 - Specific technical performance



GOTECH oil & gas price website

Properties of Natural & Glass Fibres

Property	Glass	Flax	Hemp
Diameter (μm)	10-20	19	25
Density (g/cm^3)	2.54	1.4 - 1.5	1.48
Tensile modulus (GPa)	72	50 - 70	30 - 60
Tensile strength (MPa)	1500	500 - 900	300 - 800
Elongation to failure (%)	4.8	1.5 - 4	2 - 4
Specific tensile modulus ($\text{GPa}/\text{g}/\text{cm}^3$)	28	41	30
Specific tensile strength ($\text{MPa}/\text{g}/\text{cm}^3$)	590	480	370

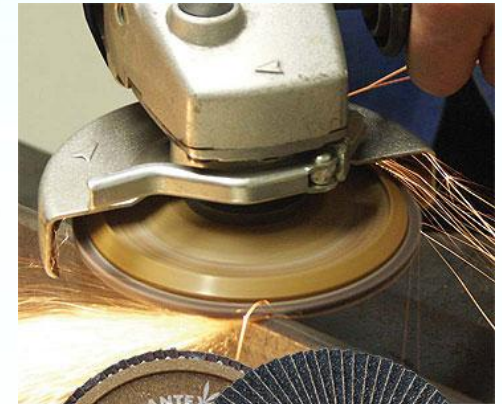
Current Applications



Automotive interior parts
(Hemp/flax mats, pressed)



Cosmetics packaging
(Flax-PP, injection moulded)



Grinding discs
(Hemp-PP, injection moulded)



Decking/furniture
(Wood-PP or PE, extruded)



Bicycle frames
(Flax)

Limitations of Current Biocomposites

■ Short, randomly oriented fibres

- Injection and extrusion moulding
- Press forming of non-woven mats



Limited mechanical properties

■ Synthetic polymers

- Polypropylene
- Unsaturated polyester



Not fully renewable



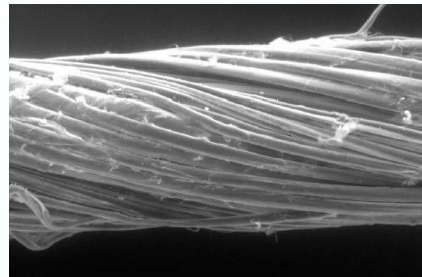
Our Goal: High Performance & 100% Bio

■ Natural fibres

- Fibres with high intrinsic mechanical properties
- Continuous, aligned fibre textiles
- Good compatibility with resins
- Improved durability, moisture resistance, fire resistance etc.

■ Bioresins

- High bio content resin systems
- Improved processing characteristics (viscosity, cure etc.)
- Improved properties (stiffness, strength, toughness, fire)



UK Collaborative Project

■ UK TSB collaborative project

- Low twist yarns and aligned textiles
- Combine with thermoplastic biopolymers
- Demonstrator components
- Testing and evaluation

■ Natural fibres

- European bast fibres
- Flax: readily available, good quality, acceptable price
- Hemp: potentially lower cost, but currently lower quality

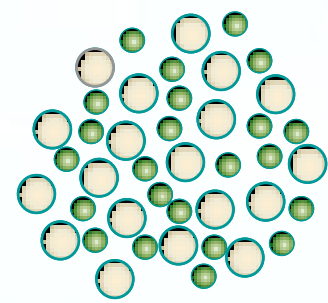
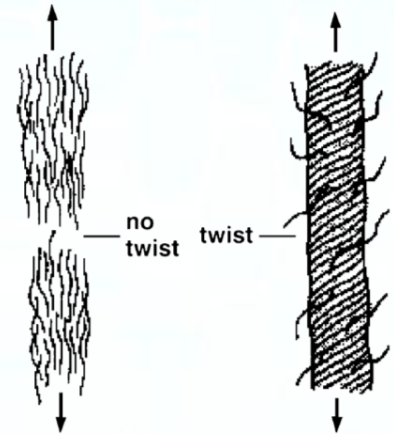
■ Polymers/biopolymers

- Polypropylene (PP): low cost, well established, synthetic
- Polylactic acid (PLA): biopolymer, interesting properties, biodegradable/compostable



Development of Yarns

- Yarns developed using novel 'twistless' spinning techniques
 - Straight fibres
 - Good mechanical properties
 - Good wet-out/impregnation
- **Natural fibre yarns**
 - Flax, hemp and hybrids
- **Commingled/blended yarns**
 - Flax/PP, Flax/PLA
 - Hemp/PP, Hemp/PLA



○ Polymer filaments/films (PP or PLA)
● Natural fibres (Hemp or Linen)

Development of Fabrics

- **Woven fabrics developed**
 - Various weave styles and constructions
 - Designed to minimise crimp, maximise drape and obtain even coverage
- **Natural fibre fabrics**
 - Suitable for hand lay-up, vacuum infusion and RTM with thermoset resins
- **Commingled NF-thermoplastic fabrics**
 - Vacuum consolidation & press moulding



Moulding Process Development

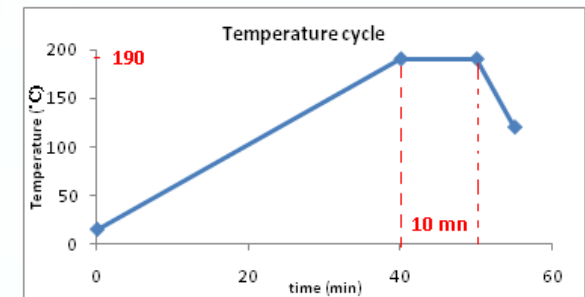
■ Vacuum consolidation

- For low volumes or prototypes
- Fabric placed under vacuum bag
- Heated in oven, then cooled
- Different temperature and times



■ Press moulding

- For higher volumes and flat sheets
- Fabric placed between aluminium plates
- Heated, pressed and cooled
- Different temperatures, times and pressures



Typical Mechanical Properties

Property	40% woven Flax/PLA (press)	40% woven Flax/PP (press)	33% woven Flax/UP (infusion)	30% UD Flax/UP (infusion)
Density (g/cm ³)	1.34	1.13	1.33	1.32
Tensile modulus (GPa)	13.2	8.1	7.2	18.8
Tensile strength (MPa)	102	56	68	174
Elongation (%)	1.6	1.5	2.5	1.5
Flexural modulus (GPa)	7.8	4.5	4	15.1
Flexural strength (MPa)	131	79	97	196
Charpy impact, unnotched, flatwise (kJ/m ²)	33	27	28	
Charpy impact, unnotched edgewise (kJ/m ²)	28	23	28	

Commercialisation

■ Development successful

- Materials with good performance & processability
- Significant interest from the composites industry

■ Materials commercialised

- Biotex (trade name)
- Composites Evolution Ltd

■ Materials supplier

- Specializing in innovative sustainable composites
- Formed in 2009
- Spin-off company of NetComposites
- Capacity 500T/year

■ Current portfolio

- Biotex natural composites
- Self-reinforced plastics



Biotex Material Types

- **Flax, commingled Flax/PLA & Flax/PP**

- Other fibres possible e.g. Jute, RCF
- Other polymers e.g. PE, PET, PA etc.

- **Yarns**

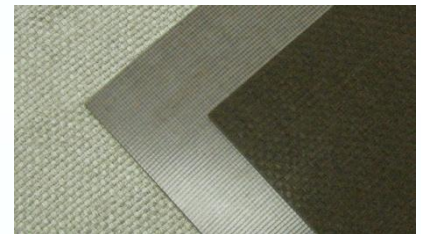
- 125-2000tex

- **Fabrics**

- Woven and non-crimp multiaxials
- 250-800gsm

- **Preconsolidated sheets**

- 0.8-2.8mm thick



Advantages & Applications

Advantages

- Sustainability
 - Renewable composites with low impact
- Performance
 - Twistless technology for high properties
- Processing
 - Good impregnation

Applications

- Transport
 - Automotive, Aerospace, Marine
- Construction
- Industrial
- Sports & leisure
- Consumer goods



Current Application Developments

Automotive

- Jaguar XF rear door module
 - Flax/PP, 35% weight saving
- Land Rover Defender door module
 - Flax/PP, 60% weight saving



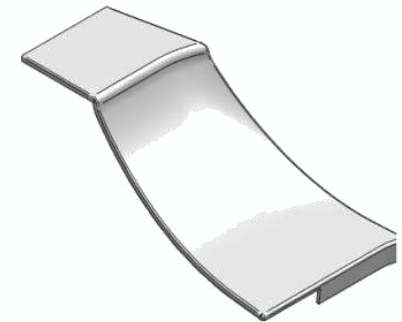
Marine

- Fairline Boats headliner
 - Flax/PLA



Industrial

- Grit bin covers



Current Application Developments

Consumer Goods

- Fibershell iPad cover
 - Flax/PLA
 - Natural/technical appearance



Sporting Goods

- Snowboards (numerous)
- Kamanu Composites canoe
- Flaxland canoe
 - Single skin of flax over wooden frame
 - UV cured bioresin

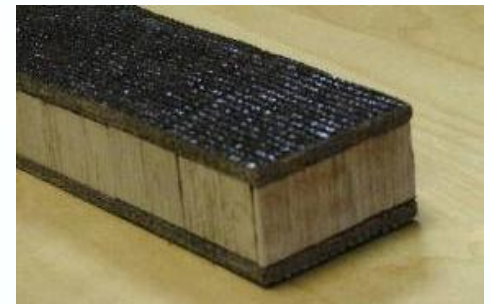


Construction

- House under construction in Australia

Current Material Developments

- **Flax-thermoplastic tapes**
 - Up to 100mm wide
- **Prepregs**
 - Epoxy, bioresins etc.
- **Fire-retardant systems**
 - Mass transport, construction
 - Furan bioresin (FR)
- **Lightweight sandwich panels**
 - Cork, balsa, PLA honeycomb cores



Summary & Conclusions

- Significant interest in biocomposites from industry
- Existing natural fibre composites have limitations
- A new family of high performance natural composites have been developed
- Flax, commingled Flax/PLA & Flax/PP
- Yarns, fabrics and preconsolidated sheets
- Commercialised with the name Biotex
- Range of customer applications under development
- Further materials development – tape, FR etc.



Thank you for listening

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