Cost effective lignin-based carbon fibres for innovative light-weight applications
Overview

The overall objective of GreenLight is to develop a new biobased, renewable and economically viable carbon fibre precursor “lignin”. The lignin (sourced from pulp mills) is a green, sustainable, abundant and cost-efficient new carbon fibre precursor. Within the GreenLight project the aim is to produce a cost-effective biobased carbon fibre for use as a reinforcement in polymer composite materials.
Technical Objectives

1. Tailor an optimal lignin material suitable to **extrude**, stabilise and carbonise

2. Establish **optimised spinning conditions** for multifilament melt spinning of lignin

3. Produce **multifilament lignin precursor yarns**. From 100 to 1000 filaments

4. Produce multifilament lignin-based CF with target mechanical properties of: **tensile strength 1.72 GPa**, and **tensile modulus 172 GPa**

5. Establish **suitable surface treatments** for optimised interface strength of lignin-based CF and selected polymer resins
Consortium

RISE (Coordinator)
Södra
FIBRE (Faserinstitut Bremen)
Fourné Machinenbau
STFI (Saechsisches Textilforschungsinstitut)
SWEREA Sicomp
NetComposites
Blatraden
CRF (Centro Ricerche Fiat)
Consortium

Södra (Sweden)
Biomass, pulping, black liquor, characterization & technoeconomy

RISE (Sweden)
Lignin recovery, chemistry, characterization, conversion & technoeconomy

Swerea SICOMP (Sweden)
CF surface treatment, interface chemistry, composite development, composite modeling, layup and testing

Fourné (Germany)
Scale up of continuous conversion

FIBRE (Germany)
Scale up of fibre spinning

NetComposites (UK)
Composite development, part simulation and integration, dissemination & exploitation

STFI (Germany)
Filament handling, tows, weaving

Blatraden (Sweden)
Composite development, part design

Fiat CRF (Italy)
Composite development, part design, manufacture, testing
Project

- This project has received funding from the Bio Based Industries Joint Undertaking under the European Union’s Horizon 2020 Research and Innovation programme under grant agreement No 667501

Budget
2.6 M€ (Financing: 50% EU, 50% Södra)

Coordinator
RISE

Duration
1 July 2015 – 30 June 2019

Website
http://greenlight-project.eu/
Work Programme

- **Raw Mat/Chem**
- **Equipment**
- **Fibers/Fabric**
- **Mat. supplier**
- **Tier 1**
- **End Users**

- Thermoset prepreg
- Fabric
- Resin Transfer moulding
- Compression moulding
- TP laminates
- TP pellets
- Injection moulding

**GreenLight**

667501 – GreenLight – Cost effective lignin-based carbon fibres for innovative light-weight applications
WP1: Lignin pre-processing and filaments
WP2: Stabilisation and carbonisation
WP3: Continuous processing
WP4: Carbon fibre composites
WP5: Scalability & Sustainability
WP6: Dissemination & Exploitation
WP7: Management
Work Programme

Dissemination & Exploitation

- Kraft black liquor feed
- LignoBoost high purity lignin recovery
- Extrusion studies
- Conversion studies
- Surface treatment studies
- Composite simulation / part modeling
- Pilot extrusion

Scalability & sustainability

- Carbon fibre line
- Weaving
- Composites
- Performance
- Automotive
Why lignin-based carbon fibre?

• Increased replacement of steel with carbon fibre composites
• Requirement to decrease weight and fuel consumption of the car fleet
• High demand for cost-efficient carbon fibres. Biobased is a bonus

GreenLight concept

• Utilize lignin, a wood component that is largely a by-product from pulp mills, as a raw material for cost-efficient and “green” carbon fibres.
The need for alternative CF precursors

- Structured carbons produced from PAN, pitches and regenerated celluloses

- Celluloses used for fibres & machined parts are the most expensive:
  - additional fibre treatment needed, slow conversion, low carbon yields
  - low tensile, low modulus, high thermal resistivity

- Pitches, used for fibres, foams, and monoliths, are the next most expensive
  - highly refined, need a certain pretreatment, small market
  - lower tensile, high modulus, high thermal and electrical conductivity

- PAN used for fibres are the least expensive ca. €20/kg
  - expensive solution spun precursor and conversion
  - high tensile, medium modulus, low thermal and electrical conductivity

- In each case the precursor is industrially optimized for final application

Structured carbons in fibre, foam, monolith and other formats are needed
Current market for composite fibers

- Competitive parameters
  - Strength
  - Modulus
  - Weight
  - Ash content
  - Price
  - Composite design

Current market for composite fibers

![Graph showing the current market for composite fibers with various parameters and materials.](image-url)

- **S-glass** (€15/kg)
- **Basalt** (€4/kg)
- **E-glass** (€1/kg)
- **High Tensile** (€15-50/kg)
- **Intermediate Modulus** (€50-200/kg)
- **High Modulus** (€120/kg)

![Diagram with GreenLight highlighted](image-url)
Costs of PAN carbon fibre

20 Euro/kg: low due to current crude oil price

Precursor: is considered to be the fibre used to make the CF, not the original polymer – the filament spinning process is important

Cost reduction – current state of the art

- Textile grade PAN fiber: solution spun
- Alternative conversion and large scale tow processing
- Another synthetic polymer, e.g. PE
- Lignin / cellulose blends: similar to Rayon CF
- By replacing it with melt spun LIGNIN ... but it has 50% lower cost
Automotive - Drivers for Innovation

CO₂ problem / Global warming

The “last generation” engines with the Energy Saving measures allowed to achieve today targets

New technologies to achieve the 2020/2025 CO₂ emission targets

Individual customer demands

Each exceeding g CO₂/km will cost 95€ to the OEM: hybridization, aerodynamics, energy management and weight reduction

Limited resources

New style effects and personalization for high perceived quality

Environmental friendly materials and recycling improvements
Automotive - CF potential applications

PLASTIC REPLACEMENT

BODY
- Body in white
- Closures
- Semi-structural aesthetic parts

UNDER BONNET
- Structural parts
- Aesthetic covers
- Hoses

INTERIORS
- Seat and dashboard structural parts
- Semi-structural aesthetic parts

METAL REPLACEMENT

CHASSIS
- Structure
- Beams
- Steering & Suspensions
- Wheels

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Automotive - CF market trends

Carbon fibre demand for all market

Focus on automotive (Composite Marktbericht 2013)
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