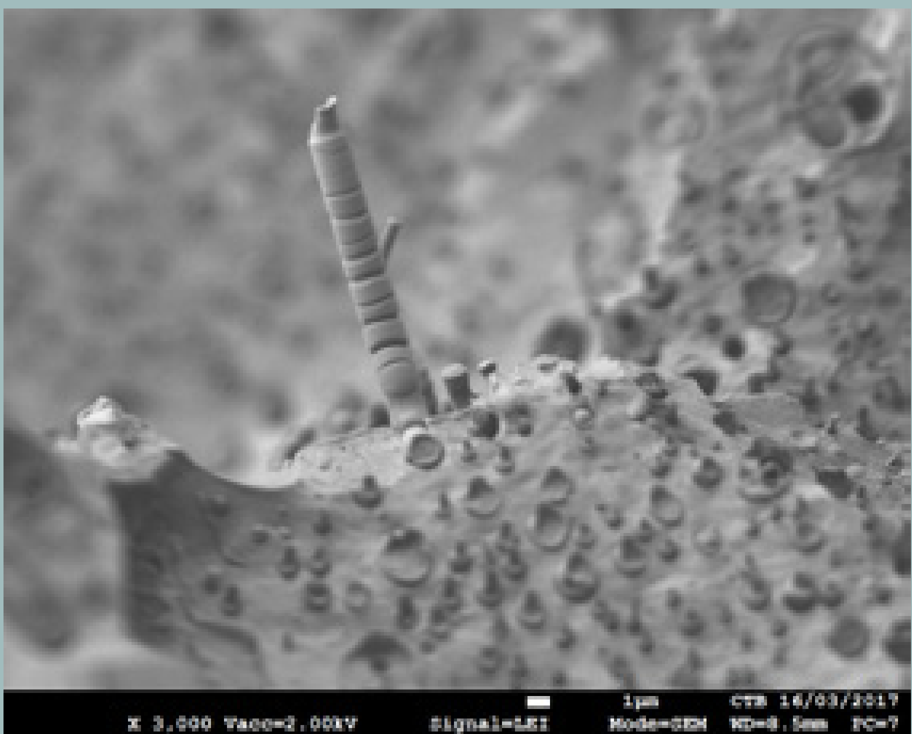
Centexbel-VKC

INFO

Nieuwsbrief voor de textiel- en kunststofverwerkende industrie | 2017 - 04

Vezelversterkte composieten



SEM image of the month

PP reinforced with polymer microfibrils

Inhoud

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Fotografie: Marc Van Hove

Bio in hars en vezel

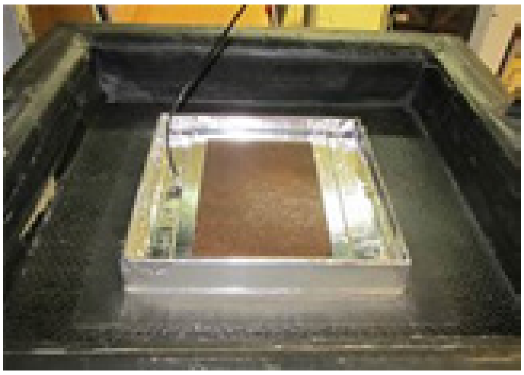
Composieten uit 100% biogebaseerde materialen

Hoewel biogebaseerde composieten doorgaans zijn samengesteld uit natuurlijke vezels, bestaat de matrix nog steeds uit fossiele grondstoffen. Die matrix maakt echter een groot deel uit van de composiet en daarom wordt gezocht naar het gebruik van biogebaseerde harsen in de productie van composieten, die de naam "biogebaseerd" écht verdienen.

Interreg France-Wallonie-Vlaanderen

GoTo53 BIOCOMPAL

Frederik Goethals | frg@centexbel.be



Centexbel-VKC realiseerde in een afgelopen onderzoeksproject[1] 100% biogebaseerde composieten op basis van een nonwoven uit vlas en polyfurfuryl alcoholhars.

De vlasdoeken werden geïmpregneerd met het biohars en vervolgens samengeperst tot een composietplaat.

Polyfurfuryl alcohol wordt gemaakt uit het afval van suikerriet. De brandvertragende eigenschappen van dit hars compenseren de brandbaarheid van de natuurlijke vezels zodat het uiteindelijke product slaagt voor brandtesten volgens de strenge normen uit de automobielsector.

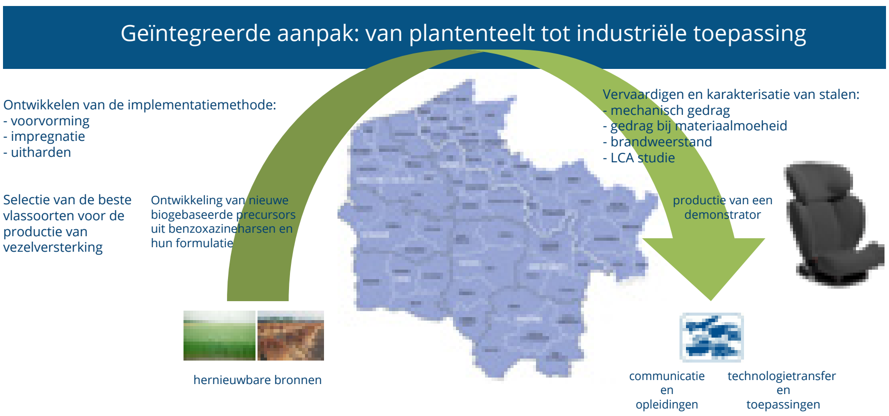
Het brandgedrag van de composieten werd getest volgens de horizontale brandtest beschreven in FMVSS 302 (Federal Motor Vehicle Safety Standards - Flammability of interior materials - 49CFR571.302) en de verticale brandtest volgens UL94.

Dankzij de brandwerende eigenschappen van het biogebaseerde hars slagen de composietpanelen voor de FMVSS 302 test. Om een score van V0 te behalen in de UL94 test moeten de vezels vooraf een vlamvertragende behandeling ondergaan.

In het Interreg project **BIOCOMPAL** dat nog tot eind juli 2020 loopt zullen we biogebaseerde composieten ontwikkelen **op basis van continue vlasvezels,** waarbij **benzoxazine** wordt gebruikt als **biogebaseerd hars**. Voor de ontwikkeling van deze nieuwe hoog-performante, biogebaseerde en lichte materialen met een lage CO_2-voetafdruk, wordt de biomassa uit de lokale landbouw gevaloriseerd. De composietmaterialen krijgen een structurele toepassing in de transportsector zoals luchtvaart en spoorwegen, waarvan de industrieën sterk zijn ingeplant in het INTERREG-gebied (Frankrijk, Wallonië, Vlaanderen).

Om de doelstellingen te bereiken worden de complementaire expertises samengevoegd uit:

- Wallonië waar MATERIA NOVA de nodige expertise heeft in de ontwikkeling van biogebeaseerde en hoog-performonante polymeerharsen
- Vlaanderen waar INAGRO expert is in de vlasteelt en Centexbel-VKC in het ontwerpen en vervaardigen van textielversterkingen
- Frankrijk waar ARMINES DOUAI over de kennis beschikt in verband met de productietechnieken van composieten en hun modellering



[1] Sabcaa project [IWT - 140425]

Bio4Self

Biobased self-functionalised and self-reinforced composites

PLA is considered as one of the most promising biobased polymers and is therefore most frequently used. However, there are still some drawbacks which prevent its wider commercialization in many applications. This is mainly due to the lower mechanical performance and durability when compared to conventional polymers. The development of a self-reinforced polymer composite (SRPC) will enhance the mechanical performance of PLA. In an SRPC, the matrix and reinforcing phases are from the same polymer or polymer family.

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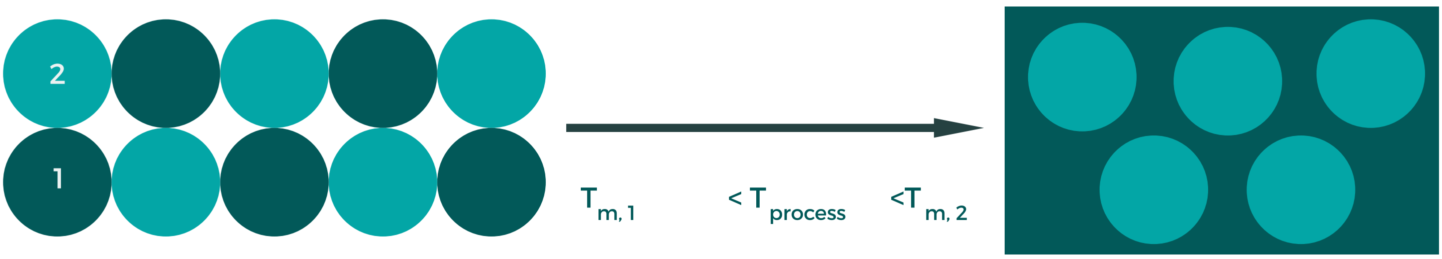
Centexbel-VKC coordinates the H2020 project BIO4SELF that aims at developing polylactic acid (PLA) self-reinforced composite materials with a high mechanical performance that is even superior to currently existing solutions.

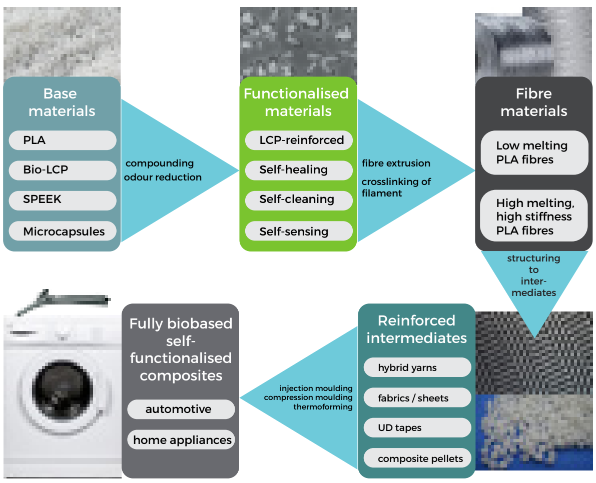
Self-reinforced polymer composites (SRPC) composites offer interesting properties:

- lightweight: high specific stiffness and strength
- high impact resistance
- excellent fibre-matrix adhesion
- inherent thermo-formability
- easy recycling

Because PLA can be produced with controlled molecular configuration resulting in PLA grades with a range of different melting points, it is ideal to be used in an SRPC. The picture below shows the principle of combining two PLA grades, one with a low melting temperature (Tm,2) and a second with a high melting temperature (Tm,1) to create a self-reinforced composite.



The BIO4SELF project will develop fully biosourced self-reinforced polymer composites, based on two PLA grades: one to form the matrix and a high melting grade to form the high stiffness reinforcing fibres. To obtain unprecedented stiffness, the PLA will be combined with a bio-LCP (Liquid Crystalline Polymer) to create an extra reinforcement level. Furthermore, the temperature resistance of PLA and its durability will be improved.



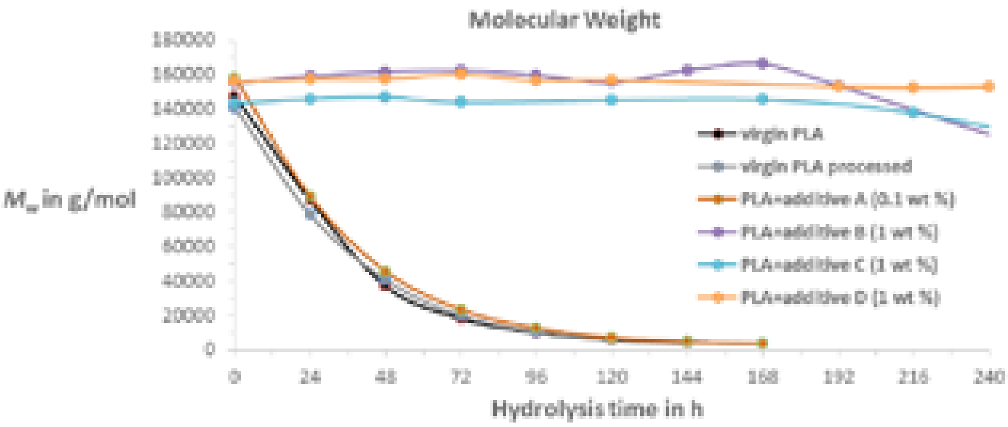
The potential of the biobased self-reinforced materials will be validated in advanced prototypes for automotive and home appliances. The project aims at a cost-efficient production of sustainable and fully biobased composites with high technical performances. To reach this goal, the whole value chain is represented in the BIO4SELF project.

innovations all along the value chain are needed to reach the project's goal

BIO4SELF developments covering all process steps after only 1 year

Project partner **Mirtec** obtained very promising results in the hydrolytic stabilisation of PLA materials. The hydrolytic stability of PLA-based polymers during processing, storage and use is crucial for a successful commercialisation, especially in applications with a long lifetime. Therefore, different additives have been selected and tested including an epoxy-based chain extender, as well as short and long chain, aliphatic and aromatic carbodiimides. Some of the tested additives were very successful in improving the hydrolysis stability.

The right choice of additives improves the hydrolitic stability of PLA, as is shown by the prevention of molecular weight decrease (tested at 70 °C and 80% RH)



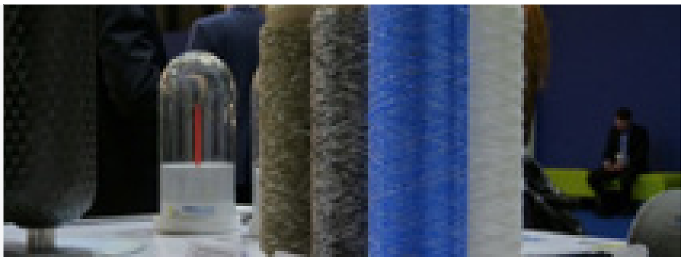
Centexbel-VKC has developed high Tm PLA filaments via melt extrusion. The challenge is to produce filaments with a maximum stiffness resulting in an optimal reinforcing effect in the final composite part. The modulus or stifness of the filaments is optimized by adjusting the extrusion parameters.

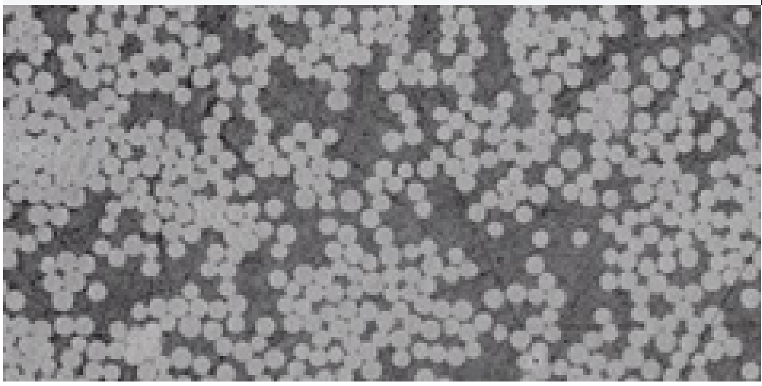
We observed that spinnerets with a high capillary length over diameter ratio (L/D ratio) are beneficial to the modulus of the resulting multifilaments.

Also a high cold draw ratio results in a higher modulus. In general, the multifilaments, with a titer of 5 dpf (dtex per filament), reached a stiffness of approx. 9 GPa. This was also the optimal value we obtained in the case of monofilaments, with titers ranging from 50 to 100 tex.

In the coming months, additional strategies, mainly focussing on the introduction of (bio)-Liquid Crystalline Polymers as an extra reinforcement in the reinforcing fibres, will be studied to further maximize the stiffness of the filaments.

Project partner **ITA** produced low melting PLA filaments that were successfully combined with high melting filaments into hybrid yarns.





In the final step, the hybrid yarns are used to produce unidirectional composites resulting in a fully consolidated composite plate by partner DTU.

The first tests indicate that the initial strength of the high Tm filaments has not been affected by the consolidation proces.

The project will now focus on the optimisation of all process steps in order to maximise the mechanical performance, as well as on the functionalisation of the composite parts.

Subscribe to the project newsletter at www.bio4self.eu

Acknowledgment: we thank project partners MIRTEC, DTU and ITA for their contribution to this overview.

BIO4SELF receives funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 685614.

Celfi

Schimmelwerend maken van Wood Plastic Components

Wood Plastic Composites (WPC) zijn bijzonder interessante producten omwille van hun lage kostprijs. Ze zijn immers samengesteld uit lage kost commodity-kunststoffen zoals PVC, PP of PE en bestaan voor 70% uit houtmeel dat slechts 0,4 tot 0,8 euro/kg kost. Hout is minder duur, stijver en sterker dan kunststoffen wat het meteen interessant maakt als versterkingsvulstof. Het project Celfi faciliteert en ondersteunt de ontwikkeling, productie, toepassing en recyclage van WPC's via technologisch advies over grond- en hulpstoffen, normen, testmethodes, applicatie- en assemblagetechnieken van WPC's en over de verschillende toepassingsdomeinen.

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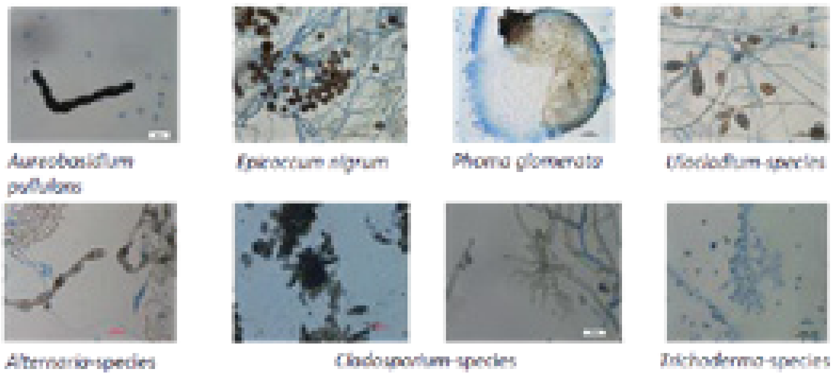
Het versterken van thermoplastische kunststoffen met cellulosevezels verlaagt niet alleen de kostprijs, het verbetert eveneens de eigenschappen van de kunststoffen en omdat cellulose een biogebaseerde grondstof is verkrijgen we tegelijk een duurzamer materiaal.

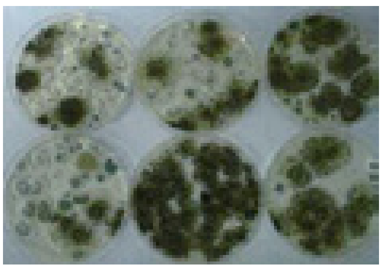
Aanvankelijk waren WPC producenten er vast van overtuigd dat WPC materialen bestand zouden zijn tegen biodegradatie omdat de houtvezels zijn ingebed in een kunststofmatrix en omdat in de productie vaak polyolefines worden gebruikt die tevens immuun zijn tegen biodegradatie.

Helaas worden WPC aangetast door schimmels. De houtvezels die zich aan het oppervlak bevinden creëren een capillair effect zodat water wordt opgenomen in de materialen en de schimmelgroei wordt bevorderd. De schimmels leiden tot verkleuring, vlekvorming, gewichtsverlies en uiteindelijk tot een verlies van mechanische eigenschappen.

Om te overleven en te groeien hebben schimmels naast een voedingsbron, voldoende vocht (> 30%), een temperatuur tussen 24°C en 30°C en natuurlijk zuurstof nodig. Omdat noch de temperatuur noch de zuurstof kan worden beïnvloed, kan het probleem verholpen worden door de hoeveelheid hout te verminderen of door de houtvezels volledig in te kapselen, met verlies van de gewenste houtlook. Geen van beide oplossingen is echter ideaal.



Een alternatief is het materiaal te behandelen met een antimicrobieel product. In het kader van Celfi werden verschillende antimicrobiële producten getest in een WPC-matrix. De schimmelvorming en resistentie werden getest volgens EN 5534-1 en ISO 846.



Testen tonen aan dat de schimmelgroei drastisch vermindert door het toevoegen van een antimicrobieel product.

In het kader van het project worden bijkomende testen uitgevoerd om de ideale concentratie te bepalen waarbij het additief werkzaam is en om het eventuele uitlogen te evalueren.

Fotoreeks fungi © IHD

Vlaio traject - 145005

AGENTSCHAP INNOVEREN & ONDERNEMEN Vlaanderen is ondernemen

FeneCom

Fast and energy efficient UV curing

In the processing of thermoset composites, the curing step is extremely time-consuming resulting in long processing times and low production rates. Moreover, it is also a highly energy-consuming activity. Both factors increase the production costs. Therfefore, composite manufactures are eagerly looking for alternative methods to speed up the process and lower the production costs. The FeneCom project launched on May 1st 2017, will look into the possibilities of UV-curing as a fast and energy efficient curing process.

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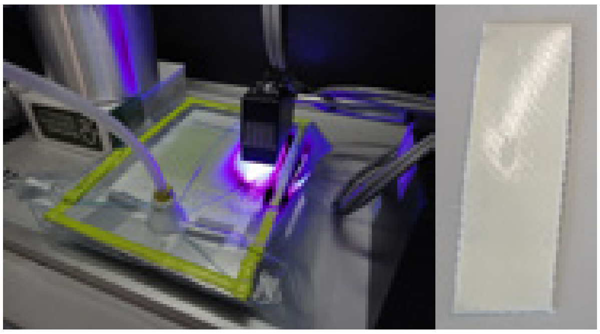

A previous project examining the possibilities of UV curing - LEDcure - proved that glass fibre composites can be perfectly cured in a fast and efficient manner by using UV-LED light (see picture).

However this was only feasible because glass fibre composites are UVA transparent, which does not apply to the many composite varieties containing carbon or aramid fibres.

In the new project, FeneCom, we will broaden the scope and develop efficient methods to cure composites containing non UV-transparent fibres. Because fire retardant properties are required by many applications this feature will also be studied in this project.

Research strategies

- **Developing hybrid fabrics**: UV-transparent fibres such as optical yarns or glass will be incorporated in basalt or carbon fabrics (braids and weaves) and even in recycled carbon nonwovens. These fabrics and nonwovens will then be impregnated with UV-curable resins.
- **The UV-transparent fibres** will enable UV –light to go deeper into the material leading to better through curing.
- **Dry preforms:** The fibre bundles of glass and carbon fabrics come easily loose, making them difficult to handle. UV-curable resins will be used to fix these fibre bundles in the fabric while maintaining the flexibility and drapeability of the textile preform.
- **Infrared curing**: Infrared light is a more efficient technique to heat up materials compared to convection heating and it will be investigated if this technique can be used as drying method to obtain prepregs or even for full curing.
- **Dual curing**: dual cure resins can be cured by light or by heat. The resin at the surface of the prepreg and thus reachable by the light will cure instantly and will make that the composite is dry and can be easily transported. Full curing is then achieved by time or heat.
- **Fire retardancy** will be obtained by adding FR additives or by using FR resins.

The project targets suppliers of raw material (resins and FR additives), the textile industry (producing textile reinforcements), the textile coating and finishing industry (formulations and fibre impregnation) as well as the composite industry (laminating and curing).

Cornet project (funded by Flanders Innovation & Enterpreneurship - HBC.2016.0666)

Libre

Lignin based carbon fibres for composites

Carbon fiber is a reinforcement which when added to plastic improves its mechanical properties thereby forming a composite material. Composites are used in many products including automotive parts and wind-turbine blades. However, carbon fiber is currently produced from petroleum which is expensive and detrimental to the environment. The LIBRE project aims to create carbon fiber materials in a cost-effective and more environmentally friendly way, by producing them from a naturally derived wood product called 'lignin'.

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The high costs, limited production capacity in Europe and the use of petroleum-based polyacrylonitrile (PAN) as the carbon fibre precursor, necessitate the development of innovative routes to industrial production.

One of the innovative routes is to use lignin as precursor.

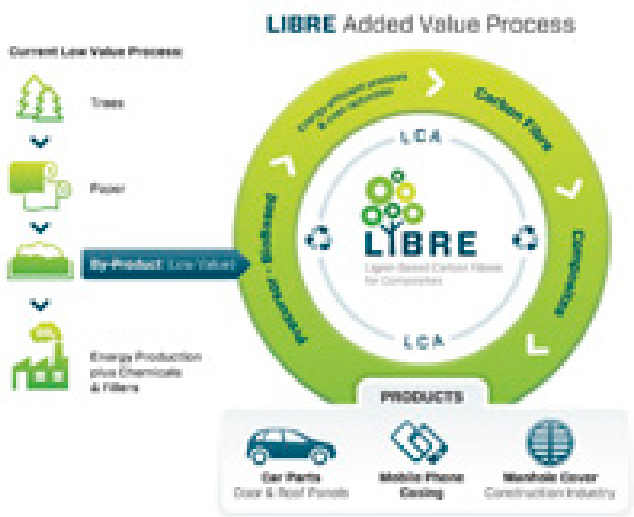
Lignin is an organic polymer derived from wood that confers mechanical strength to plants and trees. It acts as the glue of the cell walls, helping the cellulose and hemicellulose to remain in a stable structure.

In the production of paper from wood, the cellulose has to be separated from the hemicellulose and lignin. Lignin is thus a low-value waste stream of the paper industry.

Turning this waste stream into a precursor for the production of carbon fibres would not only allow us to move away from the reliance on fossil fuels, but also to reduce the production costs.

Research steps

- Development of new bio-based composite materials utilising lignin from the pulp and paper industry blended with biopolymers as a precursor.
- Reductions in energy consumption and greenhouse gas emissions during the manufacturing process through the use of microwave and radio frequency (MW/RF) heating technologies.
- Surface functionalisation using non-aqueous processes to enhance performance in polymer composites
- Increased sustainability of composite materials.
- A competitive edge for end-user sectors such as transportation, renewable energy and construction.



Project website: http://libre2020.eu

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 720707

JEC 2017

Composieten of zoveel meer dan de som der delen

Omdat een composiet het resultaat is van een combinatie van minstens twee materialen, neemt het de eigenschappen van de samenstellende materialen over en verkrijgt het zelfs totaal nieuwe eigenschappen. Het ene materiaal (matrix), smelt rondom en verbindt het andere materiaal (versterkende vezel of weefsel). Onze collega's bezochten dit jaar opnieuw de JEC, de vakbeurs voor composieten, samen met vertegenwoordigers uit de volledige waardeketen grondstofleveranciers, verwerkers en eindgebruikers. JEC 2017 kreeg meer dan 40.000 bezoekers over de vloer, een stijging met 10% tegenover vorig jaar!

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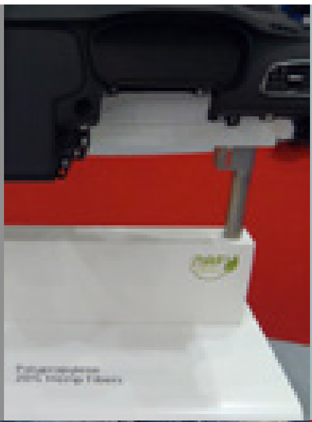
Dashboard uit thermoplastisch polypropyleen versterkt met hennepvezels.



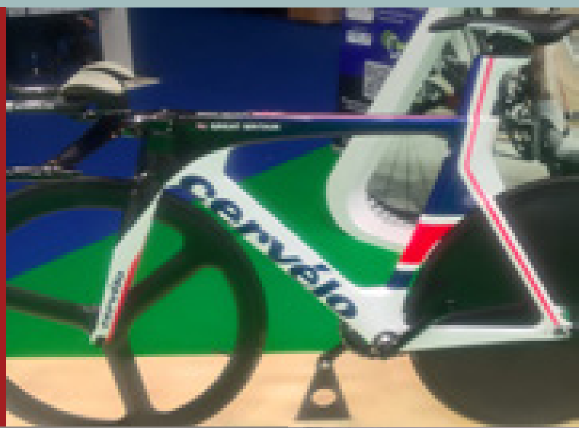
Composieten als antwoord op de uitdagingen van deze eeuw zoals milieu, duurzaamheid en innovatie.

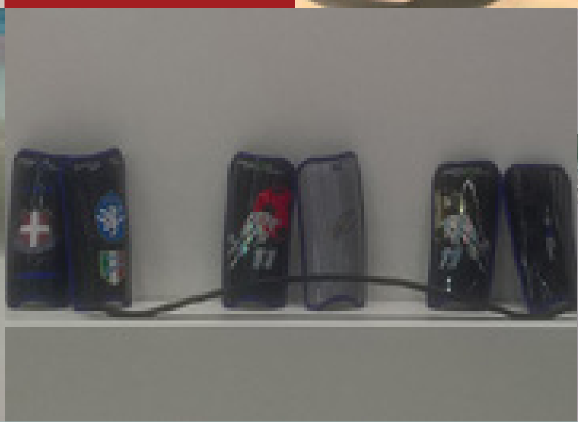
Wat meteen opviel is de prominente aanwezigheid van koolstofvezelversterkte composieten op de beurs, terwijl 95% van de huidige composieten gemaakt worden uit glasvezel. Ten tweede stelden we vast dat de nadruk vooral lag op composieten met een thermohardende matrix.

Verschillende producenten spelen in op de vraag van de overheden om natuurlijk vezels zoals vlas en hennep te gebruiken en promootten het gebruik van natuurlijke vezels en thermoplastische materialen, die gemakkelijker te recycleren zijn.

DE "USUAL SUSPECTS"

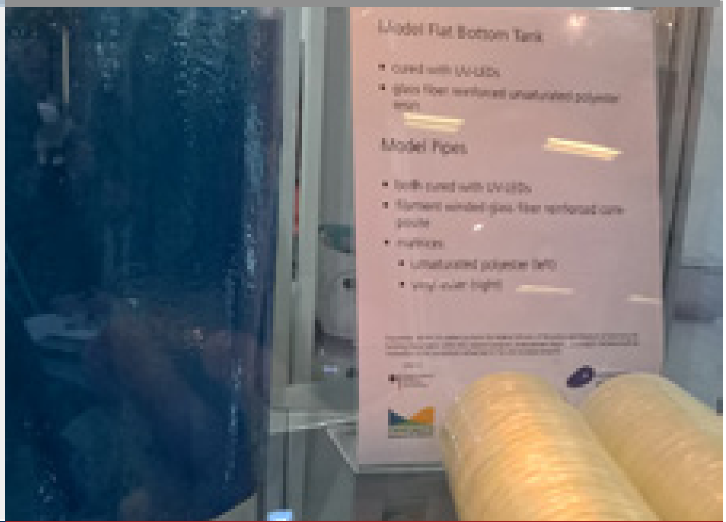
Composieten in vliegtuigen, auto's, windmolens, fietsen en boten





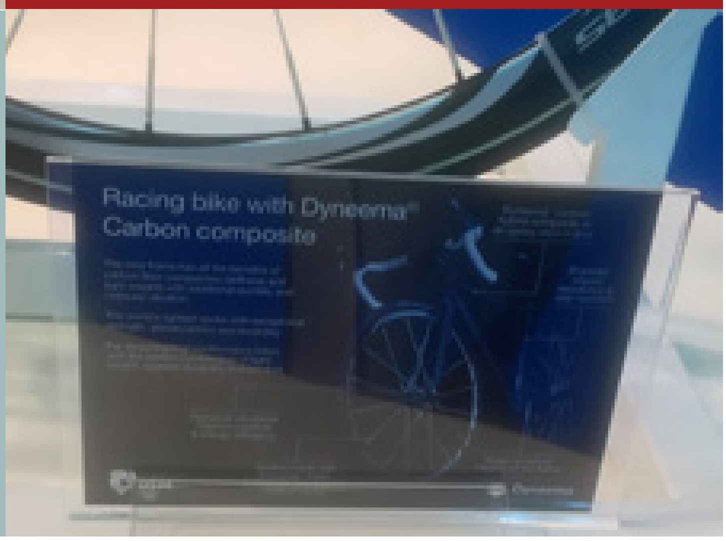
Composieten zijn veelzijdige materialen voor allerlei toepassingen
waarvan deze comfortabele en stevige babydraagtas, scheenbeenbeschermers en pingpongpalet getuigen.

Centexbel-VKC's onderzoek is gericht op biocomposieten en efficiënte uithardingsprocessen zoal UV-curing.
Beide thema's kwamen ook aan bod op de beurs.



Tenslotte geven we u nog mee dat Dyneema zich steeds meer profileert als producent van vezelversterking in composieten.

Zij stelden daarom een fiets tentoon, gemaakt uit koolstof met Dyneema als versterkingsmateriaal.
Volgens hen zou de impactbestendigheid van de fiets beter zijn dan die van de huidige koolstoffietsen.

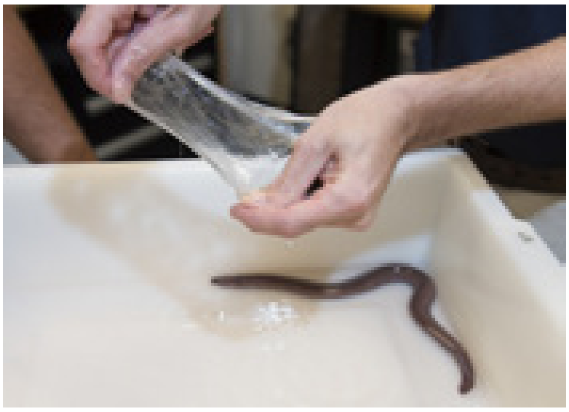


Outside-the-Box

The US Navy's new wonder material is synthetic hagfish slime

Hagfish are a bit like underwater Spidermen. When they're attacked by a predator, they shoot out a slimy substance that can seal the mouth and clog the gills of said attacker, so they can make an escape. Now, A team of US Navy scientists and engineers have figured out a way to synthesize the slime with the goal of equipping the military force with a valuable new material that could do everything from repelling sharks to providing ballistics defense.

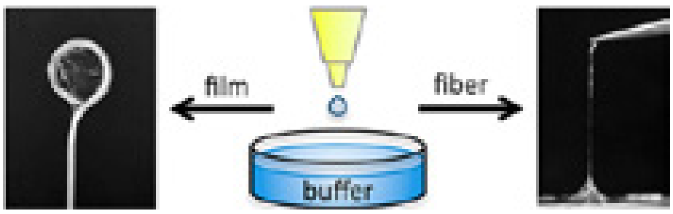
Source: Newatlas.com



Although hagfish are mostly blind eel-like bottom feeders, the defensive slime they produce is mighty indeed, and has even been compared to spider silk. It consists of two components, thread-like proteins and mucin, a gelatinous lubricant. Inside the animal, the threads, which are only 12 nanometers in width but up to 15 centimeters in length, are tightly coiled. When the slime is shot out into seawater, the proteins holding them together dissolve and the threads spring open. This unique mechanism means that a small tube of slime could quickly expand into a large underwater defensive shield.

"The coiled up thread behaves like a spring and quickly unravels upon contact with water due to stored energy," said Materials Engineer Dr. Ryan Kincer. "The mucin binds to water and constrains the flow between the micro channels created by the thread dispersion. The interaction between the thread, mucin, and seawater creates a three-dimensional, viscoelastic network. Over time, the thread begins to collapse on itself, causing the slime to slowly dissipate. Studies have shown the hagfish secretion can expand up to 10,000 times its initial volume." While hagfish slime has long been talked about as a new biomaterial, keeping a tank of the slimy critters on hand for manufacturing purposes just wouldn't be practical. So Kincer and biochemist Josh Kogot figured out a way to make the substance in the lab by enlisting the help of E. coli bacteria. They engineered the bugs to produce two of the proteins normally made by the hagfish, called alpha and gamma. They then combined them in solution where they assembled into the slime. "The synthetic hagfish slime may be used for ballistics protection, firefighting, anti-fouling, diver protection, or anti-shark spray," said Kogot. "The possibilities are endless. Our goal is to produce a substance that can act as non-lethal and non-kinetic defense to protect the warfighter."

"Researchers have called the hagfish slime one of the most unique biomaterials known," added Kincer. "For the U.S. Navy to have its hands on it or a material that acts similar would be beneficial. From a tactical standpoint, it would be interesting to have a material that can change the properties of the water at dilute concentrations in a matter of seconds."



Hagfish slime threads, which make up the fibrous component of the defensive slime of hagfishes, consist primarily of proteins from the intermediate filament family of proteins and possess impressive mechanical properties that make them attractive biomimetic models. To investigate whether solubilized intermediate filament proteins can be used to make high-performance, environmentally sustainable materials, we cast thin films on the surface of electrolyte buffers using solubilized hagfish slime thread proteins. The films were drawn into fibers, and the tensile properties were measured. Fiber mechanics depended on casting conditions and postspinning processing. Postsecondary drawing resulted in fibers with improved material properties similar to those of regenerated silk fibers. Structural analyses of the fibers revealed increased molecular alignment resulting from the second draw, but no increase in crystallinity. Our findings show promise for intermediate filament proteins as an alternative source for the design and production of high performance protein-based fibers.

Centexbel-VKC support the textile and plastic processing supply chains in the development and introduction of novel materials, innovative products and technological processes.

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