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FEATURE

Car with a biodegradable core

Liz Nickels

Liz Nickels spoke to EconCore, a technology provider for the manufacturing of structural honeycomb cores for composites, about the company's research into using PLA, a biodegradable material, for a next generation of sustainable vehicles.

Sustainable materials and electric cars seems like a marriage made in heaven. However, it is only this year that Netherlands-based student team of Eindhoven University of Technology, TU/Ecomotive claimed that it had built what it said is the world's first car made from biocomposites.

Biocomposites are generally composite materials formed by a resin and a reinforcement of natural fibres. While the reinforcement can be fibres from crops (cotton, flax or hemp), recycled wood, waste paper, crop processing byproducts or cellulose fibre such as viscose/rayon, the resin also often comes from renewable resources.

In this case, the electric car, called Lina, has a chassis, body and interior entirely made from a combination of bio-based composites and biodegradable plastics, according to TU/Ecomotive. This gives it a weight of just 310 kg, reducing the carbon footprint dramatically, even when compared to other lightweight cars.

Lina, which is 3500 mm long, 1300 mm wide and 1300–1400 mm high, has an electric drivetrain with power supplied by modular battery packs, giving a power output of 8 kW using 2 DC-motors. This allows the car to reach a top speed of 80 km/h. The car also features NFC tags in the doors, so that it can be unlocked with a smartphone.

'Lina is the next step to what we think is the car of the future,' said TU/Ecomotive in May 2017.

The bio-based composite used in the chassis, body and interior, is made from flax and a honeycomb shaped core produced from polylactic acid (PLA) bio-plastic (Fig. 4). PLA is a biodegradable and bioactive material derived from renewable resources – in this case, it is made entirely from sugar beets and is 100% biodegradable, according to the Dutch student team. PLA also reportedly generates significantly less greenhouse gas emissions over the life time when compared to traditional materials like PP. To make the core, it is placed in between two flax composite sheets to provide stiffness to the composite. The biocomposite has a strength/weight ratio similar to glass fibre, but is made in a sustainable manner, said the team.

Honeycomb core

The honeycomb material was supplied by EconCore, the worldwide leader in honeycomb sandwich technology for the continuous production of honeycomb sandwich panels (Fig. 1). The EconCore technology allows for the off-line or in-line combina-

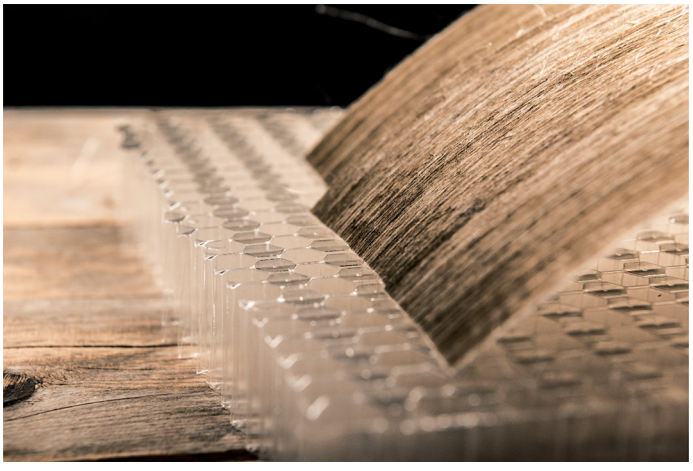

FIG. 1

The car features bioplastic honeycomb developed by honeycomb sandwich material specialist EconCore.

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FIG. 2
Students from Eindhoven University of Technology with the Lina electric car.

FIG. 3
Lina on the road.

tion of honeycomb cores made from different thermoplastics with various skin materials into lightweight sandwich panels.

EconCore's technology allows production from a single continuous thermoplastic sheet by successive in-line operations. The core is produced from a single cast extruded film by a thermoforming, a folding and a bonding operation. ThermHex honeycombs have half-closed skin strips, allowing improved bonding of skins onto the core. According to the company, the technology enables the cost-efficient production of honeycomb cores from a wide range of thermoplastic polymers with a variation in cell size, density and thickness. One problem with the use of bio-based polymer materials such as PLA is that they are still relatively expensive compared to for example PP, the company said. However, the ThermHex technology allows the processing to be relatively cost-effective, making the material a suitable alternative to non-biodegradable material.

EconCore recently optimized the production technology to produce PLA based hexagonal honeycomb cores using their ''ThermHex'' continuous production process. As soon as the core is produced skin layers are added in a second step of the continuous production process. These skins could be made from unfilled PLA material to make a mono material panel or, in case a higher performance is required, could be replaced with consolidated flax in a PLA matrix.

In May, students from Eindhoven University of Technology took Lina to the Shell Eco-marathon 2017, held from the 25 to the 28 of May in Queen Elizabeth Olympic Park, London, UK (Fig. 2). This race is designed for efficient vehicles, so that the team which uses the least amount of energy to drive their laps around the track wins the race.

While the student team met all specifications for weight, visibility, dimensions and turning, at 310 kg it unfortunately did not match the weight limit set by Shell at 225 kg (Fig. 3). However, the students took the opportunity to drive the car round during a special media shot, reaching a top speed of 55 mph.

In June, the students hosted an event at the Dutch embassy to showcase the car, including a trip to some flax fields.

I spoke to Wouter Winant who is leading the project at EconCore to develop PLA for sandwich materials.

How often is PLA used in a sandwich core for automotive applications?

It's not the main thermoplastic used in automotive applications – yet. But a lot of research and testing is done with this material. Prototypes are being made because PLA has a lot of ecological benefits. Let's say that the improvement rate of the thermoplastic is quite fast that every few years you see improved versions of the material. A few years ago, you only had PLA that could withstand 50 °C. Now there is a high heat PLA available that can withstand temperatures of 100–140 °C. So that's already a big improvement!

The Dutch company Total Corbion, which produces PLA, already advertise it for automotive applications as an alternative for polypropylene, PBT, and so on, but if look at real applications or commercial applications then I don't see it too much – or perhaps only in the matrix part of certain components.

So would you say it's currently still used for high end bespoke applications or electric cars?

It's still most prominent at the moment in prototyping and development. But I think in a few years it will be getting more and more used in automotive applications. Not just in the next 20 years – even sooner! If you look at the improvement rate, I think it will have a chance in only a few years. But that goes for other bio based thermoplastics also.

Is it becoming more common to use flax and PLA together because they're both more sustainable and ecological?

Yes, and they are already used in combination together in a matrix, as well as with PP and other thermoplastics. The only down side is that flax loses its structural properties when it's in contact with moisture so it has to be well encapsulated with a polymer. In that way, you can get a rigid sheet. However, if you combine this with a (PLA) honeycomb core you get what we call a ''sandwich effect'' were you increase the panel stiffness dramatically while the core only adds minimal to weight. In that way, you can get a very rigid material that can be used in a lot of applications or even for structural behaviour.

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