



USE OF VISIBLE NATURAL FIBRES IN VEHICLE INTERIORS

Electric mobility is a challenge to carmakers and suppliers alike. It calls for innovative technologies that result in an increased range, for example through weight reduction. Sustainable lightweight design solutions with biocomposite materials are gaining in importance, as it is shown here by Dräxlmaier with its kenaf door panelling for the BMW i3 electrical vehicle.

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BIOCOMPOSITES AS STYLING ELEMENTS?

Over the past few years, the share of natural fibre materials, such as flax, hemp or sisal in vehicle interiors has steadily increased. Weight reductions of between 20 and 50 % in interiors can be attained by using these materials rather than petrochemical injection moulded plastics, thus considerably improving the environmental performance evaluation of vehicles [1]. In the past, passengers could not see biocomposites as they were laminated by film made of plastic or leather. The use of natural fibre materials as styling elements to emphasise the ecologically sustainable character of the vehicle, was not an option. Because ultimately: The rough structure of natural fibres were not able to fulfil the Premium OEMs' demands for a high-quality appearance.

That results in the following problem: How could natural fibre materials find their way into the vehicle interiors as a styling element on the one hand, and save weight on the other hand? After several years of joint development, the automotive supplier Dräxlmaier managed to take an innovation up to series production together with the BMW Group, thus fulfilling both requirements, besides being ecologically compatible in terms of sustainability.

ADVANTAGES OF THE KENAF PLANT

The door panellings respectively the door substrate, which is visible now, as well as the instrument panel cover in the BMW i3 electric car consist of fibres from the tropical cotton family called kenaf. This hibiscus cannabinus is used because it is very fine and has very clear fibres compared to flax or hemp, which is very important for the purpose of achieving a high-quality surface appearance. That is a very important prerequisite, as the styling philosophy of the BMW i vehicles demands consistent focus on sustainability, which can be seen and felt in car interiors – and at the same time meets the OEM's demands for premium quality [2].

Besides the homogeneity of fibres needed for this, the kenaf plant that belongs to the family of bast fibre plants [3] scores points for low density at around 1.2 to 1.4 g/cm³ in its mechani-

cal characteristics and a high degree of tensile strength of about 700 MPa. And it is very useful with regards to the idea of sustainability, which many premium manufacturers have set as their goal. Finally, kenaf, that is cultivated in China, India and Thailand among other places, exhibits the best CO₂ absorption rate that exists in plant life.

In addition, neither irrigation nor artificial fertilising are necessary in producing regions like Bangladesh because of the annual floods. The kenaf leaves remain on the fields and thus provide the next generation of plants with nutrient matter. That means, that fertilisation is not only done naturally, but also that the kenaf fibres are harvested by hand – compared to Europe, where machines are used. That results in higher-than-average CO₂ credit, ❶.

A STRONG CONNECTION

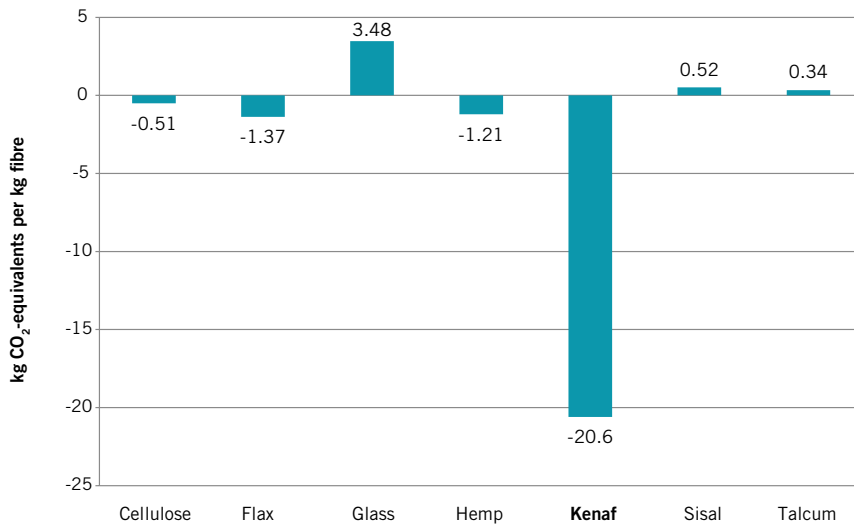
In the BMW i3 door panelling and the instrument panel cover, a kenaf natural fibre non-woven fabric is combined with fibres made of polypropylene (PP), which are with about 0,9 g/cm³ the lightest of all chemical fibres [4]. In addition, a wafer-thin black PP decorative film (200 µm) is laminated onto the surface in the manufacturing process, ❷.

The natural fibre composite material that is produced in this way also shows the advantages of material characteristics in the case of a crash: Because natural fibre-reinforced plastics (NFP) do not splinter and break without any sharp edges [5]. Basically, one can say that NFP exhibit a high degree of rigidity and strength as well as a low density. Thus, they are mechanically very resilient and light at the same time [6].

FOCUS ON LIGHTWEIGHT DESIGN

These are ideal prerequisites to cope with safety and lightweight design requirements. The mass per unit area of the BMW i3 natural fibre door substrate, including the laminated decorative film lies at 1980 g/m², ❸. That is about 1300 g/m² less than the weight of conventional plastics door substrates with film coating (3320 g/m²). In direct comparison, door panelling made of kenaf draws its trumps, as its wafer-thin decorative film has a low mass per unit area of 180 g/m².

DEVELOPMENT INTERIOR



❶ Comparison of the CO₂ balances of pure natural fibres and of reinforcement materials like glass fibres: The kenaf plant has a higher-than-average CO₂ credit

Other decors are much heavier than this: The mass per unit area of a conventionally used TPO foam film (thermoplastic elastomer on an olefin basis) is four times the weight at 720 g/m². As a result, it can be seen that when using visible natural fibre surfaces, they only have to be sealed with a comparably thin film, as their structure should remain visible to passengers as a styling element. This shows that a weight reduction of about 30 to 45 % can be achieved.

SUSTAINABLE MANUFACTURE

Value is placed on sustainability in the production process, ❷, of the kenaf

door panelling. Thus, there is no need to use adhesives, for example, when applying the decorative film described before onto the non-woven fabric. First, the solubilised natural fibres (NF) are mixed with the PP fibres in a cross-layering process. The result is an NF-PP mat 11 mm thick, which is heated and compressed in a fully automatic press line. After that, the translucent decorative film is laminated onto the heated NF-PP mat.

Then, the shape of the part geometry is received in the cold press tool under high pressure for the door substrate, and is only 2 mm thick, including the decorative film. The advantage of this proce-

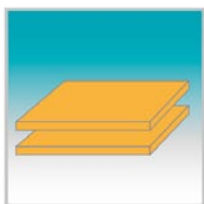
cedure: The decorative film is not applied later in a separate work step at an additional machine, as is the case in the manufacture of conventional injection molded plastic door panelling, but rather is integrated into the manufacturing process of the door substrate.

CHALLENGE OF DECORATIVE FILM

At the same time, the challenge did not merely lie in the efficient, environmentally friendly organisation of the manufacturing process. The high demands on surface touch, appearance and usability had to be also taken into consideration in the development of the thin layer PP decorative film itself and ultimately be fulfilled. Thus on the one hand, a surface feel had to be developed for the final customer that does not have a rough texture and at the same time is pleasant to touch. In addition, it was important to retain the feel of the natural structure of the fine kenaf fibres, despite the film, ❹.

There was on the other hand the challenge of developing a homogenous and mat appearance, with a uniform gloss level and colour while integrating the film into the natural fibre surface so that it is no longer visible as a coating. Finally, the decorative film still had to meet all the other requirements of surface durability, be easy to clean with commercially available cleaning agents and provide protection against mechanical, chemical and UV light impact.

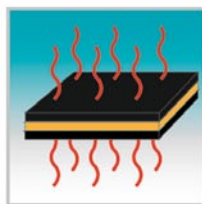
The best solution proved to be a decorative film with a three-layer structure. While the bottom layer provided the necessary adhesion for the mat and the film,



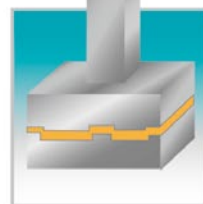
1. Pre-heating and compacting of the natural fibre fabric and the PP fibre mat



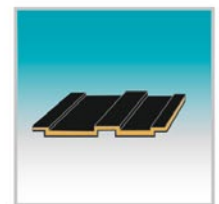
2. Pre-pressing and heating to a NF-PP mat



3. Pre-pressing and heating the mat and the decorative film

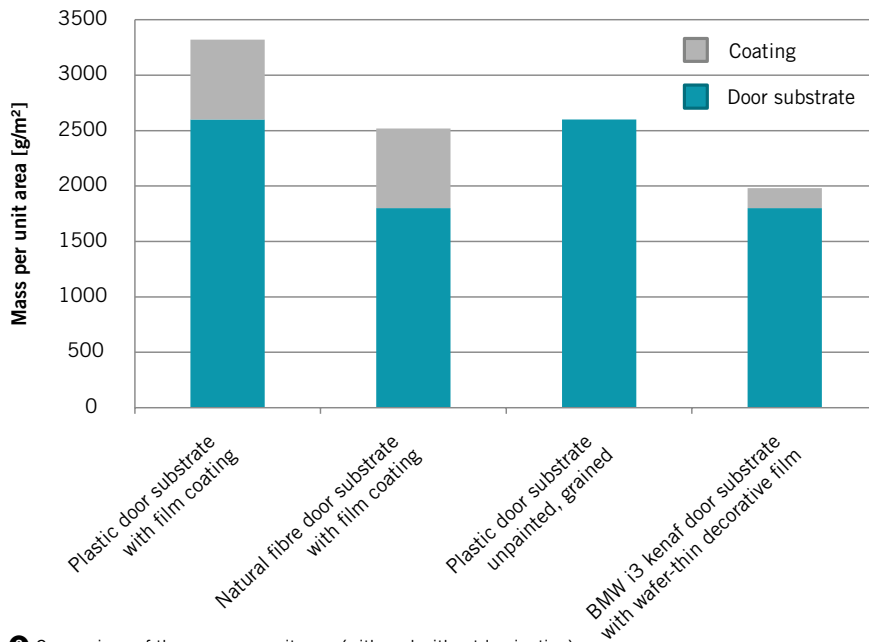


4. Moulding in the cold press tool



5. Finished natural fibre-PP door substrate with decorative film

❷ Scheme of the five-step manufacturing process for the door panelling of the BMW i3 electric car



3 Comparison of the mass per unit area (with and without lamination) of plastic with natural fibre door substrates

the middle layer provided the dark colouring and UV protection of the natural fibres. The top layer ensures that the surface feel, scratch resistance, UV stability and colour requirements are fulfilled.

PROVEN SUITABILITY FOR DAILY USE

A variety of tests was made to prove suitability for daily use. Thanks to the specially developed decorative film, the BMW i3 door panelling was not only up to standard with regards to a flammability rate of 15 mm/min, even the scratch

resistance is comparable with models made of conventional injection moulded plastic.

Olfactory characteristics of the kenaf door panelling were also tested with the VDA 270 test standard of the German Automobile Industry Association (determination of the odour characteristics of materials in vehicle interiors) and are also up to standard.

STYLING ELEMENT OF THE FUTURE

In the future, composite natural fibre materials will pay an even more impor-

tant part in vehicle interiors, as shown already by the BMW i3. They not only fulfil all the demands on lightweight design and safety, surface feel and usability. They also bring out the sustainable character of the vehicle by being visible to the passengers, 5.

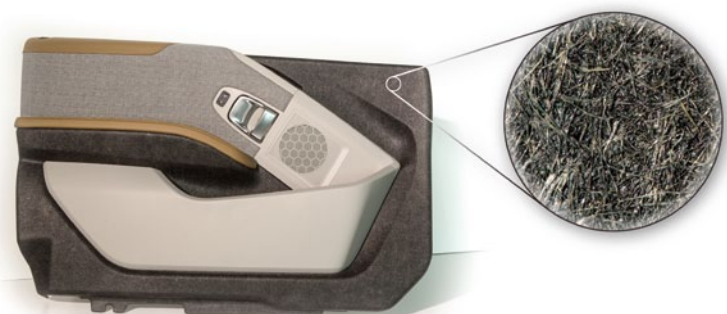
Although previously, natural fibres were concealed behind a thick film layer, they can now be seen and are finding their way even more into premium interiors as a styling element. Nonetheless, suppliers and car makers have the task of researching even more in the field of NFP and taking technologies up to series production, which will enable the share of natural fibres in vehicle interiors to increase even further.

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4 Macro shot of the fine kenaf fibre structure with laminated decorative film



5 BMW i3 door panelling (left) with enlarged view (right) of the kenaf structure