Cladding parts: Hemp replacing glass fibres

Fraunhofer IWU

Fraunhofer Institute for Machine Tools and Forming Technology

Sheet moulding compounds (SMCs) are long-fibre-reinforced semi-finished products that can be used to produce complex moulded parts with a high surface quality using the extrusion process. The Fraunhofer IWU Zittau and the Zittau/Görlitz University of Applied Sciences are researching biological alternatives for glass fibres in composite materials. The aim is to develop economical manufacturing processes so that the switch to less environmentally harmful biogenic residues for fibre reinforcement can be achieved soon.

Hemp fibres instead of glass fibres: Biogenic residues can replace synthetic fibres in SMCs, whose manufacturing process is energy-intensive. In the picture: Coarser hemp fibres on the conveyor belt before being broken down and bonded with the matrix.

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SMC components can be used in a wide range of applications. They are used as interior panelling in trains and railways, exterior panelling for trucks and agricultural machinery or to protect electrical distribution boxes

and switchgear.

Dr Rafael Cordeiro is a research associate at the Fraunhofer Plastics Centre Oberlausitz and in the LaNDER³ project at Zittau/Görlitz University of Applied Sciences. He is working in particular on train interior linings in which the glass fibre is replaced by natural fibres in combination with resin. The natural fibre used is hemp - more precisely, the coarser fibres that are a by-product of textile production using hemp. The proportion of natural fibres in the newly developed SMC is around 15 percent by weight; the planned use of bio-based resin as the matrix, i.e. the component in which the fibres are embedded, will increase the 'natural' proportion to up to 38 percent in future. Added to this are 55 percent minerals such as calcium carbonate (known as limestone or chalk) or aluminium hydroxide hydrate, which occurs naturally as bauxite. The remaining 7 per cent are predominantly petrochemical additives for which there is currently no bio-based substitute. The following are important facts about natural fibre SMCs.

Close-up of a component made of natural fibre SMCs (train interior cladding). The geometric degrees of freedom that the material allows are clearly visible in addition to the fibre flow. Photo Fraunhofer IWU

Challenges for production

One challenge for production is that natural fibres in particular bind moisture and may require prior drying in countries with high humidity, otherwise blistering may occur. The formation of bubbles also depends on the impregnation.

Dr Cordeiro: 'The natural fibre SMC has been developed in such a way that only very small additional plant investments and minimal process parameter changes are required for the production of larger quantities.'

Energy consumption during production

There are no significant differences between natural fibre and glass fibre SMCs in terms of the processes and the energy required for the production of semi-finished products and components by impact extrusion. Semi-finished products are produced at room temperature, which is why the energy requirement of the system is relatively low. The forming of components takes place in a hot pressing process in hydraulic presses, at temperatures between 110 °C and 150 °C. This temperature window is lower than that of thermoplastic components and does not require any cooling or heating cycles for the moulds, with correspondingly positive effects on energy requirements.

Impact on people and the environment

As with all plastic products, there is also the possibility of microplastic formation through abrasion. However, the natural fibre SMCs developed at the Fraunhofer IWU in Zittau are intended for the applications mentioned above, where there is no intensive abrasion. The substitution of glass fibres with hemp fibres leads to a significant reduction in skin and respiratory tract irritation among employees in the area of material and product manufacturing as well as when handling damaged parts or during disposal. In addition, the produc-

tion of hemp fibres results in significantly lower CO_2 emissions than glass fibres, which considerably reduces the environmental impact.

Dr Rafael Cordeiro is researching composite materials with natural fibres at the Fraunhofer IWU in Zittau. Photo Fraunhofer IWU

Durability

The typical service life of natural fibre SMCs is up to 30 years, depending on whether the material is used for indoor or outdoor applications. The weather resistance, for example, can be increased by specifically adjusting the matrix resin.

Biodegradability and recyclability

Similar to conventional SMCs, natural fibre SMCs cannot be recycled either. Although the latter are not biodegradable as a whole, promising attempts are being made to separate the natural fibre from the matrix and the filler so that the natural fibre portion can be composted and the filler reused. After separation, the fibres are so small that they can no longer be used in SMC applications. There is a need for further research into the technological reuse of the short fibres obtained.

Dr Rafael Cordeiro: 'The sustainability balance of natural fibre SMCs is not yet perfect. But it is already much better than that of glass fibre-reinforced composite materials. The material costs are also right. This means that the alternatives we have developed to classic glass fibre SMCs are definitely marketable. The production of more sustainable SMC components is possible.'

Source: The information on natural fibre SMCs is based on an interview conducted by Tina-Seline Göttinger with Dr Rafael Cordeiro as part of a bachelor thesis.