RECYCLING IN AEROSPACE

Recycling high-end composites for aerospace applications

"The results indicate interesting possibilites for recycling dry carbon fibres in structural applications."

Introduction

Over the years composites are getting more popular, leading to more composites waste. This is also the case at Eurocarbon, which has saved 35 ton of post-industrial dry fibre material over the last years. The material can be recycled as reinforcement for structural applications, reducing the environmental and economical impact. Reasons for the research group of Lightweight Structures, KVE composites group and Eurocarbon to cooperate and start the Recycling in Aerospace project.

Approach

The goal for this research is to study the recycling of post industrial dry fibres in a thermoplastic matrix, at following variables:

1. The process
2. The matrix material
3. The fibre length
4. The fibre volume fraction (Vf)

Plates are produced (shown in Figure 2) with different matrices (PP, PA6 and PPS), Vf (10% and 20%), fibre length (6 mm and 15 mm) and different mix-processes. A non-mixing process and a low shear mix process with rotating bars, shown in Figure 1, are used.

Dry fibres are mixed at 10 RPM with PP (10 minutes on 230°C), PA6 (15 min on 240°C) and PPS (15 minutes on 340°C) and subsequently compression moulded at 45bar. For the non-mixed process, the fibres and PP matrix are heated in the press (230°C) at 0,03 bar for 10 min and then consolidated for 5 min at 1 bar. Samples of 80x25x4 mm are cut from the plates and tested under four point bending at 2 mm/min according to ISO 14125 class 2. Mechanical properties were analytically estimated with the Rule of Mixtures (ROM).

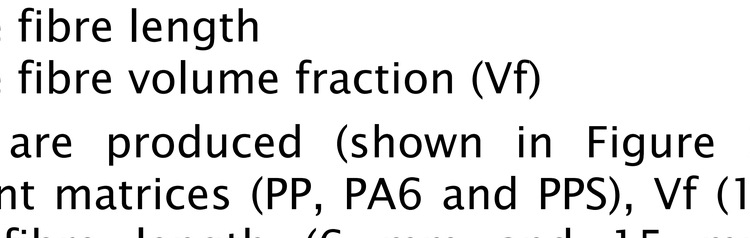

Figure 1: The mix process with rotating bars, dry fibres are mixed with matrix material and subsequently pressed into a plate

Figure 2: Plates produced at 10% Vf (left) and 20% Vf (middle) by the mixing process with rotating bars and with the non-mixed process (right).

Results

The produced plates show a large variation of mechanical properties, impregnation and mixing quality, see Figure 2. PPS with a fibre length of 6 mm and a Vf of 10% shows the best mechanical properties, relative to the calculated results using the ROM, see Figure 3. Also the PPS plate of 20% Vf shows good results on stiffness, but the strength is lower compared to the ROM. The mechanical properties of the PP and PA6 samples where low, compared to ROM. A Vf of 10% shows better properties than a Vf of 20%. The latter shows more dry fibre bundles, see Figure 2.

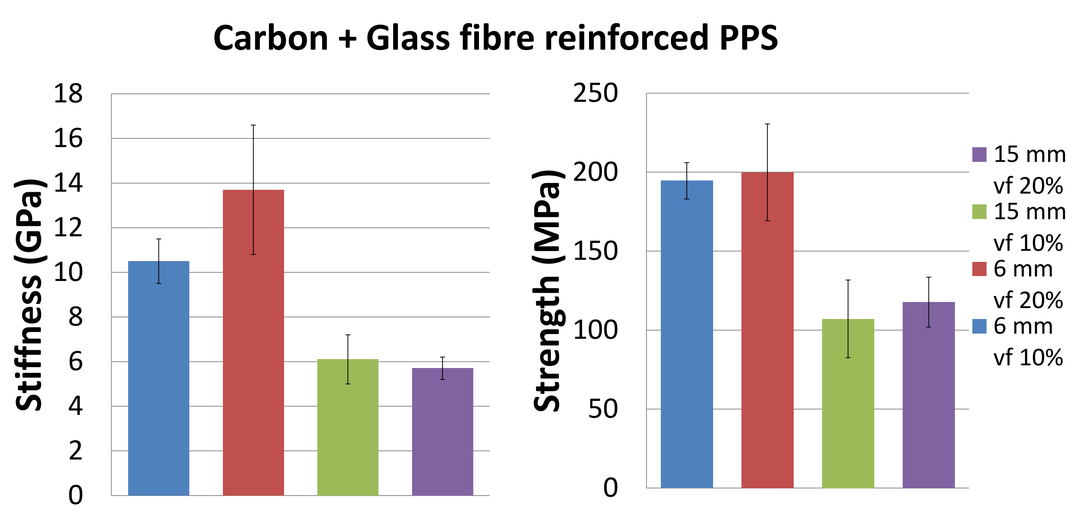

Figure 3: Experimental results of the four point bending test for fibre reinforced PPS

Cross sectional microscopy was used to study the reason for the difference in mechanical properties. Fibres were well-distributed across the plates for PPS with 6 mm fibre length and 10% Vf. However, this was not the case with the rest of the samples. An explanation can be the lower viscosity of PPS, possibly leading to a better mixing and impregnation.

Conclusion

It is possible to recycle dry fibres in a thermoplastic matrix, as shown by PPS. Mixing shows improved fibre distribution. Viscosity, and therefore matrix material has a large influence on the mixing and impregnation quality of the fibres. Fibre lengths of 6 mm result in better stiffness and strength properties than 15 mm long fibres. Only the stiffness of reinforced PPS plates increased with Vf from 10% to 20%, for strength and other materials, results are decreasing.

Recycling

TPAC THERMOPLASTIC COMPOSITES APPLICATION CENTER

KVECOMPOSITESGROUP

SiA

EUROCARBON advanced fibre braiding and weaving technology

University of Applied Sciences

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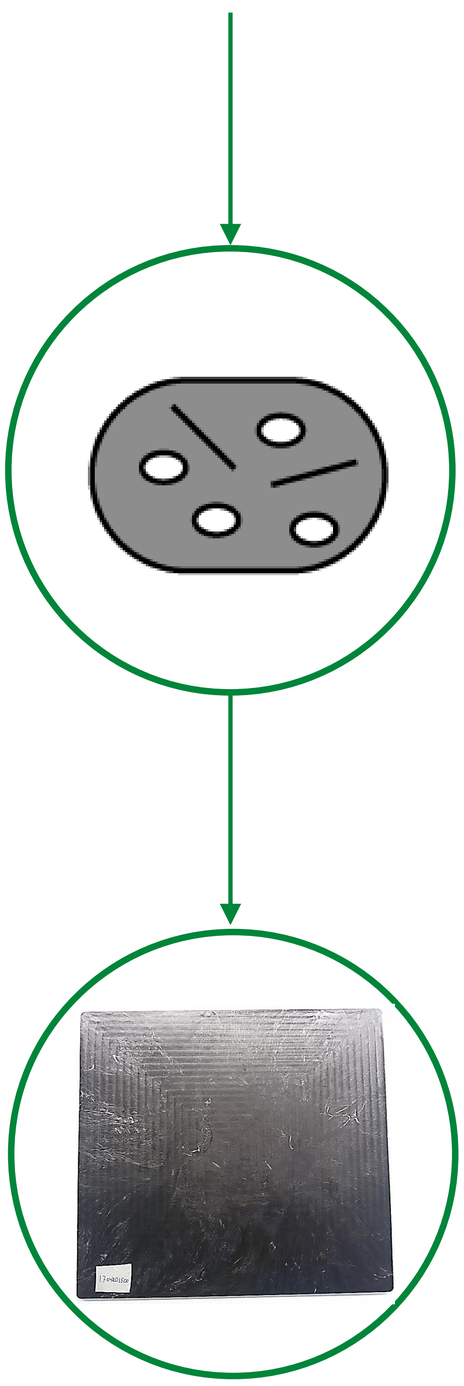
Recycling high-end composites for aerospace applications

Composition

Carbon and Glass fibers

Thermoplastic



(Semi) finished product

Recycling

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