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Closed loop recycling of carbon fibre composites with the HiPerDiF method

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SUMMARY

The HiPerDiF (High Performance Discontinuous Fibre) short fibre alignment method is used to investigate the possibility to develop a high performance, closed-loop fully recyclable composite material. In this work, the possibility to reuse short carbon fibres in a closed-loop recycling process is studied.

Keywords: Closed-loop recycling, Aligned short fibres composite

ABSTRACT

One of the main problems in industrial applications of composite materials is recycling end of life products, one way is to chop or mill them in small pieces and burn off the thermosetting matrix, obtaining short fibres, typically below 1 mm. These fibres can randomly dispersed in materials as low-grade additives for non-structural applications, such anti-static and electromagnetic interference shielding and heat conduction enhancement. However, in order to maximize economic and functional viability, recycled fibres should be reused as reinforcement for high performance structural composites. The fibre alignment level is the key factor to increase the fibre volume fraction, and consequently the performances of recycled composites [1].

The HiPerDiF method

The HiPerDiF method, developed at the University of Bristol [2], has proven to be an effective way to manufacture composite materials with high levels of alignment from short fibres, giving mechanical characteristics comparable to continuous fibre composites and a ductile or pseudo-ductile behaviour [3].

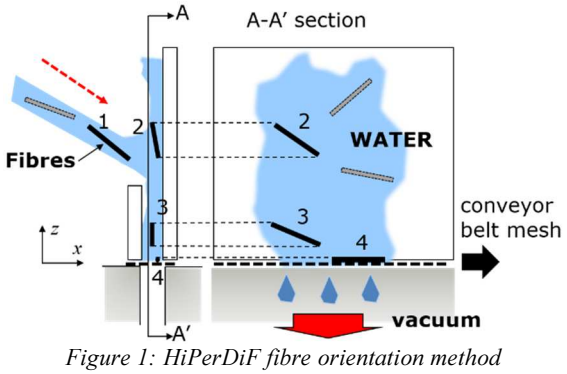

Figure 1: HiPerDiF fibre orientation method

Closed-loop short fibre recycling

This work is aimed at the development of high performance, closed-loop fully recyclable materials thanks to novel manufacturing processes and at the selection of innovative raw materials, as shown in Figure 2.

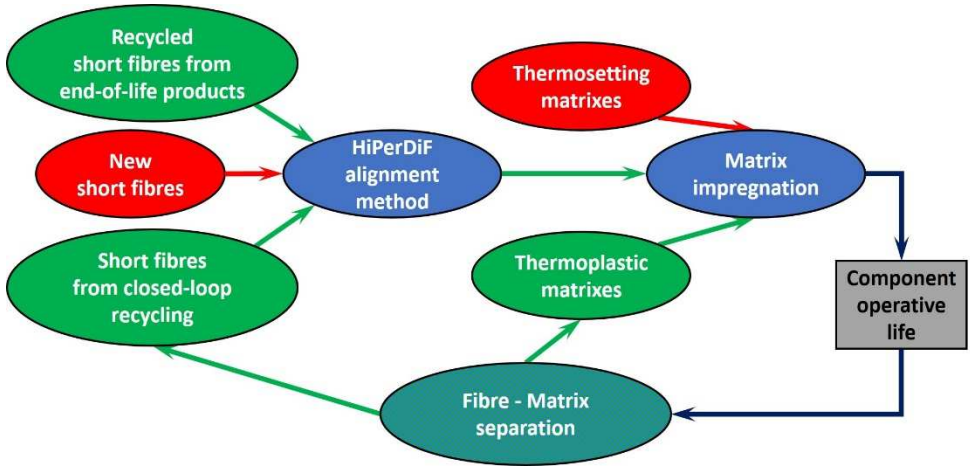

Figure 2: Closed-loop recycling process

The current work investigates the performance deterioration of short carbon fibres in an episodic matrix used in a closed-loop recycling process. Aligned short carbon fibre-epoxy specimens are produced with the HiPerDiF method and tested; the short fibres, retrieved with the pyrolysis process, are then reused as raw material for new specimens produced with the HiPerDiF method. Testing these specimens allows evaluating the effect of the closed-loop recycling process on the mechanical properties of the aligned short carbon fibre composite.

Towards the future

This work constitutes the first step towards closed-loop fully recyclable materials. More efficient fibre recovery processes and surface treatment need to be identified. Replacing thermosetting matrixes with suitable thermoplastic will allow achieving closed-loop recyclability of composite material and opening new application fields for short fibre composites.

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