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Research area: Product aims

Paper, paperboard and board // Technical specialty papers

Key words:

Semi-finished product, recycled fibres, carbon-composite, prepreg

TITLE:

Development of a wet-laid process for producing directional carbon fibre prepregs made of C fibre recyclates for use in tool construction, among other fields

Background/Problem area

Carbon fibres in composite materials are currently being used primarily in aerospace technology, in top-level competitive sport and to an ever greater extent in the automotive industry. Finished carbon fibre prepregs (woven and non-woven fabrics, prepregs) are cut to size during the production of composite components. The cuttings that are produced during the process range at present between 10% and 20% and remain largely unused. Depending on the complexity of the component, as much as 50% cuttings may accumulate. The EU End of Life Directive requires that 95% of every motor vehicle built after 2015 be recyclable. The directive is currently state of the art in automotive engineering. A similar directive for the aerospace industry is indispensible for sustainable management. It can thus be expected that there will be a continuous rise in the need to selectively recycle material in the process chain in order to reduce process-related waste.

Objectives/Research results

During the project a wet-laid process (papermaking process) is to be developed to incorporate (recycled) carbon fibres with a certain fibre-orientation to produce a semi-finished product useful for composites. It is therefore necessary to investigate how short carbon fibres can be processed in an economically worthwhile manner using the papermaking-process and how fibre orientation can be influenced. The impact of the particular paper composition, fibre length, thickness of the carbon fibres and fibre orientation on composite properties will be reviewed. Furthermore, the formability of the paper will be an important parameter. In addition, it has to be demonstrated how recycled carbon fibres can be used to produce a paper-based semi-finished product, and which paper properties are detectable when using recycled- or fresh carbon fibres. Besides, there are plans to increase the durability of carbon-based moulding tools by using ceramic fillers to improve surface smoothness, abrasiveness and vacuum-tightness.
Based on the requirements from industry, material-specific properties were derived both for the paper and for composite manufacture. Subsequently, virgin carbon fibres of varying dimensions were tested for their suitability in the wet process. At the same time, currently available recyclate fibre products were identified during a market study, and these samples were examined by optical procedures (light microscopy, SEM) regarding their fibre properties (fibre dimensions, fibre surface, fragments and contaminants). Furthermore, the focus was placed on suspensibility and separability. The highest quality products were chosen. In the subsequent laboratory trials, test series were conducted on sheet formation with virgin fibres under varying conditions of thickness and grammage with subsequent paper characterisation. The virgin fibres were able to be incorporated into the paper with good retention and satisfactory homogeneity using the Rapid-Köthen sheet former. Non-oriented paper and paper with fibre orientation were compared based on the simple paper obtained from a pilot facility of an industrial partner. Furthermore, test series with recyclate fibres were conducted on the basis of the formulation used to produce the virgin fibre paper, and the paper was characterised thereafter. Once an impregnation process that was practicable for the material and the matrix system had been identified, sample plates with varying configurations were produced. The plates of virgin and recyclate fibres were then characterised. In addition, paper consisting of up to 20mm virgin carbon fibres and several recycled fibers (fiber length up to 24mm) was produced on a pilot scale. The carbon fibres could be processed very well and were produced in the form of a paper web. The drying procedures had to be adapted in order to dry and reel up the web.

Application/Economic benefits

On the one hand, paper-based carbon media will be the initial point of a lower-cost carbon prepreg useful for carbon composites in existing applications as well as in new applications in which this material had been too expensive so far. On the other hand, it provides a solution for, until now, insufficient waste management in carbon composite process units. As the papermaking process is flexible with regard to various raw materials besides fibres, e.g. ceramic fillers, the surface properties of carbon composites can be improved in respect of durability and hardness, which is essential for the production of moulding tools. The papermaking process is inexpensive (4€/kg) compared to textile engineering (20€/kg) and also has a higher production rate. Furthermore, overall costs can be minimized using recycled carbon fibres instead of virgin fibres.

Period of time: 01.01.2012-30.04.2014

Remarks

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