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Research area: Product aims

Paper, paperboard and board // technical specialty papers

Key words:

Semi-finished product, recycled fibres, carbon-composite, "organo-sheet"material

Title:

Fiber-length-optimized recycling process for manufacturing of carbonfiber-multilayered-organo-sheets with high surface quality

Background/Problem area

Carbon fiber composites are commonly used for high-end applications in aerospace technology, top-level competitive sport and to an increasing extent in the automotive industry. Finished carbon fibre composites (woven and non-woven fabrics encouraged with organic matrix) 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. Carbon fibers are produced in energy-intensive processes and should be considered as valuable raw-material. Therefore it is of particular importance to selectively recycle material in the process chain in order to reduce process-related waste.

Objectives/Research results

The project is aimed at the development of a recycling-process-chain in lab-scale, which allows reutilization of 97% recycled Carbon Fibers (rCF) to a multi-layered composite material. The present state of material efficiency for recovery from rCF is approximately 70 %, that rate is insufficient considering the requirement of the EU Directive 2000/53 / EC on end-of -life components in the automotive industry. That leads to the following scientific and technological research objectives: Process chain with two paths on a laboratory scale for recycling RCF with an overall efficiency of 97 %; Modified opening and cleaning process of excretion short carbon fibers in the length range 6-18 mm smaller; Process for fiber gentle aerodynamic web formation from rCF and thermoplastic fibers with uniform mixing for quasi-isotropic RCF mixed fabrics; Recipe for RCF mixed fabrics with high mechanical resistance; Technically , economically and environmentally optimized paper composition and process parameters for the production of carbon paper from the secluded rCF; Development and production of a new multi-layer composite material with isotropic material properties as a material for use as a steel sheet alternative; knowledge about the relationship between the fiber characteristics , the production process and the final products produced; Mechanical characteristics of developed multilayer structure for component design.

The project was successfully finished in March 2017. The developed process combination enables the layer-wise design of staple fiber reinforcements for organo-sheets. Long fibers and directed structures can be placed in layers with high expected loads, while short fibers can be added for surface design and bending flexibility. It was shown that the tensile strength of the hybrid reinforced organo sheets outperformed the strength of the chosen benchmark product (CAMISMA) with 26 GPa Tensile-E-Modulus. A car seat with carbon fiber nonwovens reinforced backing, was chosen as demonstrator. The seat was produced with a state-of-the-art film-stacking process and achieved a c-fiber volume ratio of 25%.

Application/Economic benefits

On the one hand, paper-based organic-sheet media will be the initial point of a lower-cost composite 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 thickness of the media and mixing with thermoplastic components, it is possible to manufacture an organic-sheet-material in a one-step-process and to avoid an additional impregnation step. Also flow paths were minimized by blending the matrix fibers into the carbon fiber nonwovens, hence process pressure can be reduced and matrix outflow during consolidation was minimized. The feasibility study at the end of the project showed that the FullCycle approach reduced production costs in comparison to the state-of-the-art benchmark process by 28%. This reductions is mainly based on the higher material yield, reduced costs for PA6 fibers instead of PA6 foils (film stacking) as well as the reduced cycle time in the heat pressing step. Altogether, the feasibility of staple fiber nonwovens-based organo-sheets can strongly be improved.

Period of time: 01.07.2014 – 31.06.2016

Remarks

The research project IGF 18717 was funded by the German Federal Ministry of Economic Affairs and Technology (BMWi) and carried out in cooperation with the ITA of RWTH Aachen and the LCC (Institute for Carbon Composites, TUM).