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- 1 Bulk molding compound (BMC) based on shredded carbon fibers.
- 2 Carbon fiber patches cut to 20 x 20 mm.
- 3 Fiber-reinforced printing filament.

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## RECYCLING OF CFRP

### HOLISTIC APPROACH FOR THE RE-USE OF CARBON FIBER WASTE

#### Motivation

Lightweight materials, such as fiber-reinforced plastics, have been used in automobiles for many years and play an important role in reducing fuel consumption and CO<sub>2</sub> emissions. Compared to conventional materials, they differ significantly in their production and use. In general, fiber-reinforced plastic components are associated with higher production costs and poorer recycling properties than monolithic materials.

The recycling, and here for example the reintroduction of carbon fibers into the production process, will make a significant contribution to sustainable production. Fiber waste occurs in various stages of the production or life cycle of carbon-fiber-reinforced plastics in various qualities. In the context of several research projects, Fraunhofer ICT is working on the comprehensive and holistic recycling of carbon fibers.

#### Project reCaP

In the project "Process Development for the Recycling of Carbon Fibers in Production – reCaP", methods for the direct recycling of carbon fiber waste in the production process are developed with the aid of fundamental investigations into the interactions of the fiber processing and recovery processes with the fiber qualities and properties.

The main focus here is on dry fiber waste, e.g. resulting from cut-offs from preforming processes. This approach is designed to make direct use of residual materials and to conserve primary fibers. The investigations are supported by simulation and modeling of the recycled fibers in new plastic components. Finally, the ecological advantage of fiber-reinforced plastic components with recycled fibers is investigated by ecological and economic balancing of the product life cycle.

IN COOPERATION WITH

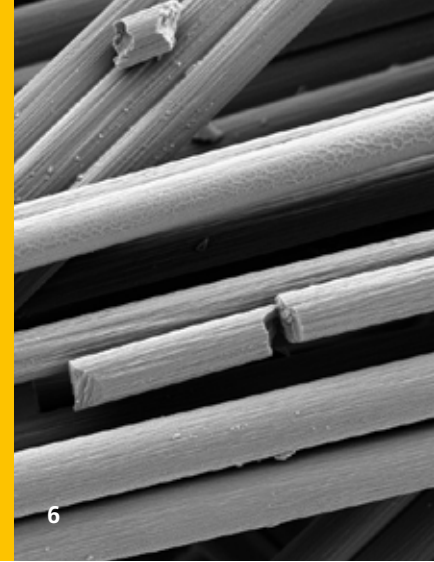




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### Project RETRO

The project "RETRO" is dedicated to the development of hybrid materials made of recycled carbon fibers and polymers for use as battery housings or as a coating for the bipolar plates of redox flow batteries and fuel cells. The fibers used are taken from end-of-life CFRP components. By developing efficient technologies for the recovery of carbon fibers from end-of-life components, material and energy resources necessary for the production of new fibers can be saved and waste can be avoided. With the use of recycled carbon fibers from lightweight construction as a coating material for bipolar plates and in battery boxes, a lifecycle management in the field of electromobility is achieved and thus the resource efficiency is increased. The project covers the technology development for the recovery of the carbon fibers from CFRP components and production waste (also with microwave-

based pyrolysis processes), the material development for components in energy storage (electrodes, housings) adapted to specific requirements, the accompanying characterization of the materials as well as the evaluation of the economic and environmental effects.

### Project Recycl3D

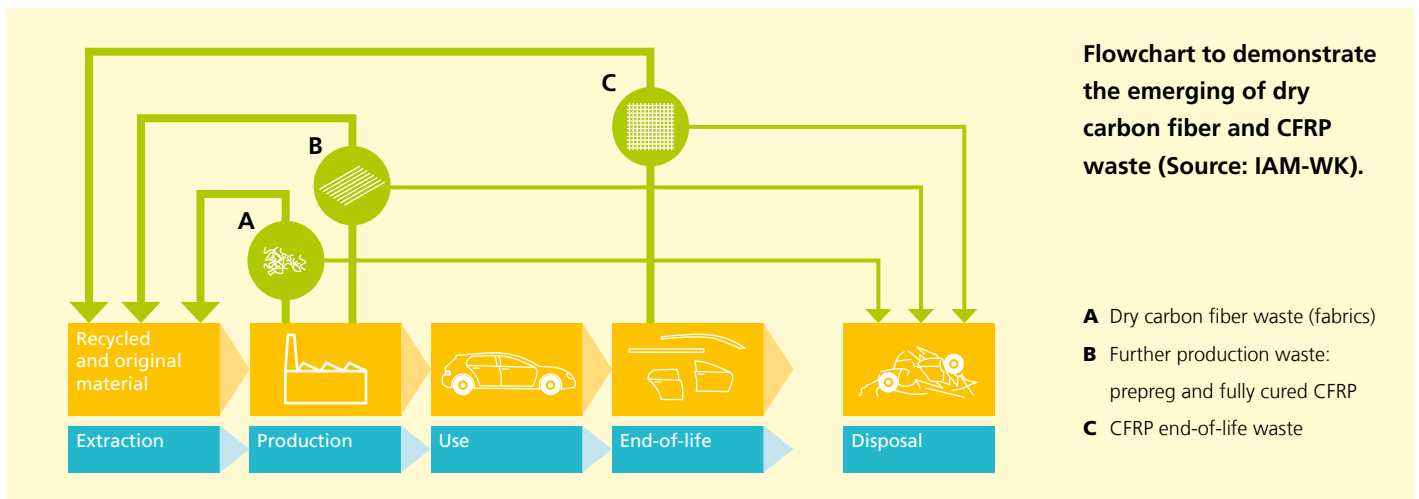
The aim of the project "Recycl3D" is the manufacturing and processing of a carbon fiber-reinforced filament for 3D printing, which consists entirely of recycled materials. This means that both the carbon fibers used and the polymer matrix material consists of recycled end-of-life components. The project includes the recovery of recycled fibers, the production of the printing filament, the processing of the latter in 3D printing, the examination of the resulting component properties and the presentation of a technological demonstrator part. The results are published as part of a utilization

strategy in which the research results are intended in particular to help the small and medium-sized enterprises active in these areas in Baden-Württemberg.

### Funded by



- 4 Quasistatic tensile test for a BMC-CFRP specimen with the aid of digital image correlation to determine strains.
- 5 BMC-sheet made of carbon fiber fabric production waste in the mold.
- 6 SEM micrograph of carbon fibers recovered from thermal pyrolysis.



Flowchart to demonstrate the emerging of dry carbon fiber and CFRP waste (Source: IAM-WK).

- A Dry carbon fiber waste (fabrics)
- B Further production waste: prepreg and fully cured CFRP
- C CFRP end-of-life waste