Final Report

Project acronym: *3D-CFRP*

Project number*: 859832*

M-ERA.NET Call 2016

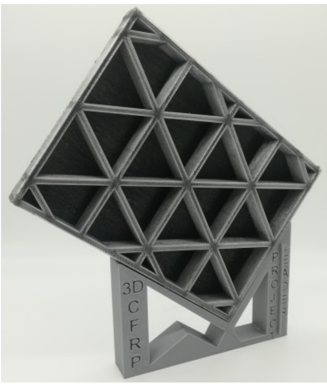
Period covered: 01/05/2017 to 31/10/2020

Publishable project summary

Within the 3-year M-ERA.NET project "3D-CFRP" international industrial partners, universities and research organizations worked together on the development of new material combinations as well as the optimization and adaptation, respectively, of processing methods for the production of additively manufactured structural components made of continuous-fibre-reinforced (thermo)plastics (CFRP).

Within the funded project ("3D-CFRP"), two local solutions to produce continuous fibre reinforced structural parts were considered. On the one hand the separate input of the fibre-bundle and polymer filament to the 3D composite printer and the realization of the composite filament inside of the 3D printer head. On the other hand the fibre-bundle and polymer constituents are initially processed into a single composite filament, which is then feed into a standard 3D printer head.

To reach the goals set, two individual composite print heads were developed and successfully integrated in desktop 3D printers. For the design process of the print head and melt channel, respectively, the results of computational fluid dynamics simulations were taken into account. Furthermore, a pilot scale production of the FRP-filaments (fibre-reinforced-polymer-filaments) were developed. For the shaping and encapsulation of the selected continuous carbon and natural fibres with the defined thermoplastic polymers, a new modular extrusion tool was designed. Mathematical modelling were used for the design optimization. Throug the addition of particulate carbon fibres to the polymer constituent, the carbon fibre volume content and in further consequence mechanical properties could be improved significantly.



Material and structural characterizations showed the high performance and potential of the polymer composite materials for the aircraft and aerospace industry. The physical tests were evaluated and validated via finite element modeling. The simulation of 4-point bending tests according to ASTM D7264 showed a good match between physical test and FEM in reaction force and bending line. Preliminary FE analysis and the determination of the principal strain trajectories allows to reinforce the printed parts where it is necessary. To generate the customized tool path designs, a special software called "NanoG-Code" was used.

For the simulation and modelling of the solidification phase after the lay-up as well as material and structural characterization a developed Additive Manufacturing plugin for the simulation software Abaqus was used. This software extension allows to simulate the whole print of structural parts via the incrementally activation of de-activated mesh of the final part along the printing history.

The chosen isogrid structure is constituted by a thin skin reinforced with a lattice structure (triangular integral stiffening ribs). The triangular pattern is very efficient because it retains rigidity while saving material and therefore weight. This structures are very often used in the aircraft and aerospace industries because of the equal properties measured in any direction.