FACULTY OF ENGINEERING AND ARCHITECTURE

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ADDITIVELY MANUFACTURED CONTINUOUS FIBRE COMPOSITES, REALLY TAKING OFF?

Intro

Continuous fibre composites consist of a (thermoplastic) polymer matrix (Figure 1, beige) and a reinforcing material, e.g. carbon fibres (gray). Composites have important advantages compared to classical materials such as metals:

- high stiffness and strength
- high fatigue strength
- anisotropy tailoring
- low density

Using additive manufacturing (aka 3D-printing) techniques, labour intensive manual composite lay-up processes can be avoided. Also, these techniques enable the production of innovative and more complex shapes.

Applications

Load bearing components where limited weight is critical for reducing CO_2 emission, fuel saving or ergonomics:

- aeronautics (Figure 3)
- aerospace
- transport on land
- medicine (orthesis, tools)
- high-end sport equipment

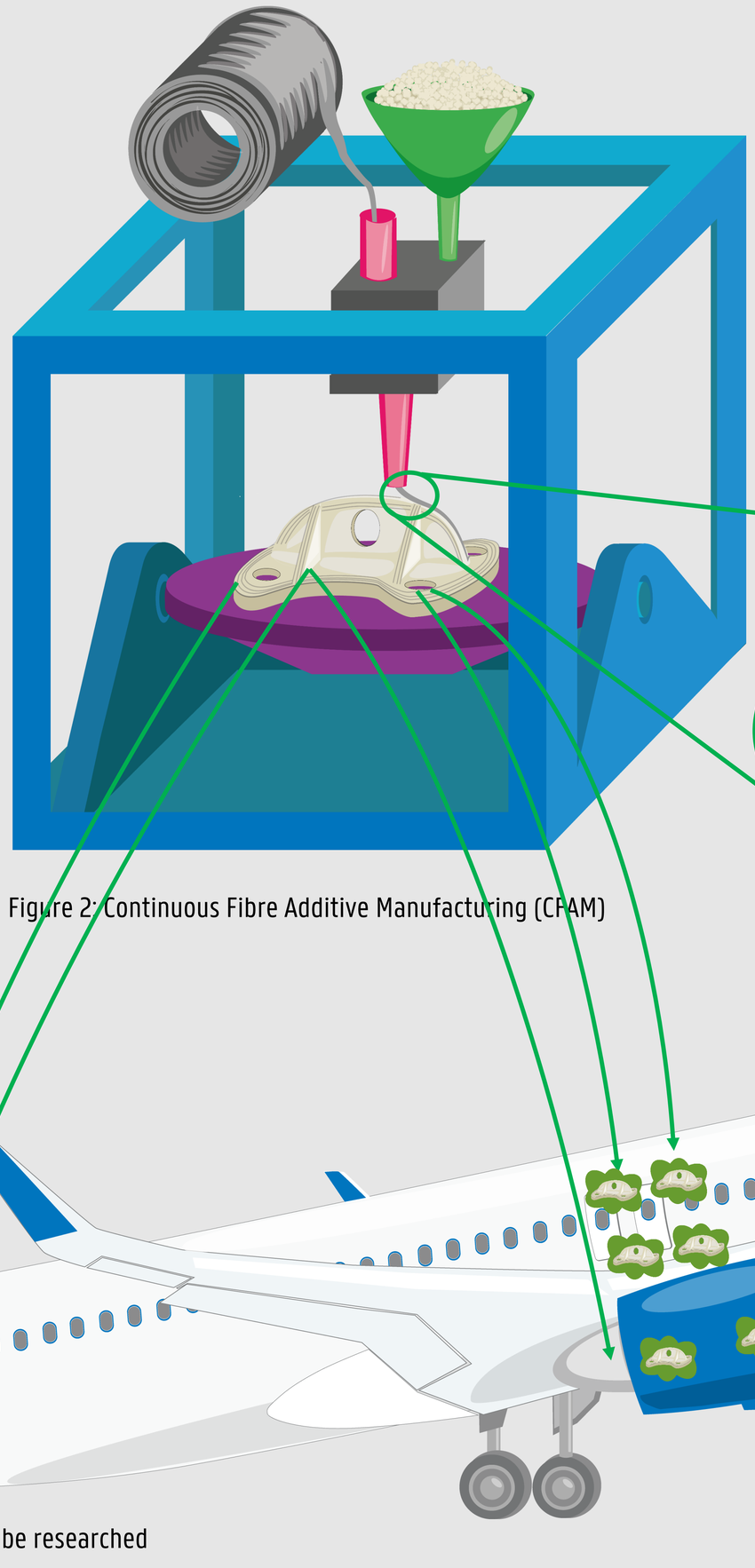

Figure 2: Continuous Fibre Additive Manufacturing (CFAM)

Continuous Fibre Additive Manufacturing (CFAM)

Continuous fibres and polymer pellets are fed into a print head (Figure 2, black box). High viscosity of thermoplastic polymers impedes the impregnation process of the fibre bundle. The effects of temperature, shear rate and pressure on the impregnation process were studied.

Printer development

A heavy-duty printer that can handle composite lay-up forces was developed. A full 3D 5-axis lay-up technique was developed to be able to fully tailor fibre direction, and thus stiffness and strength of a component.

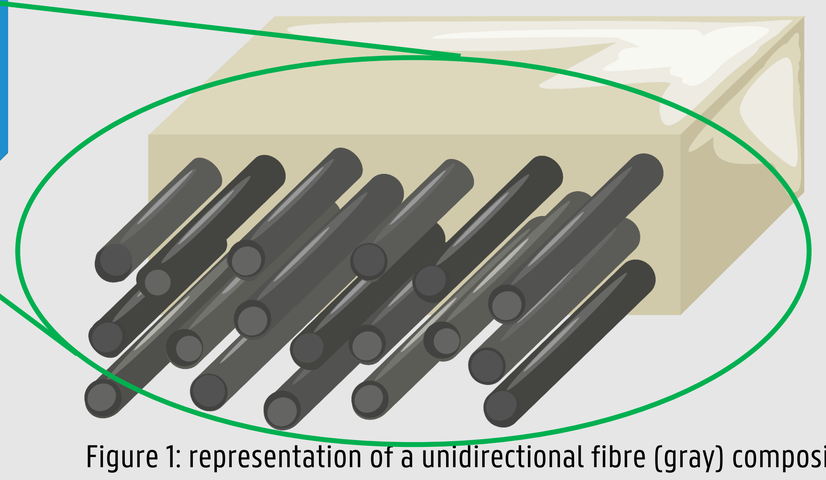

Figure 1: representation of a unidirectional fibre (gray) composite

Figure 3: the feasibility of CFAM door hinge brackets will be researched

Material characterisation

Material properties such as intra- and inter-layer cohesion, yield strength, stiffness, maximum fibre fraction, void fraction, fibre dispersion and distribution in the matrix are determined and compared to the values of classically produced composites.

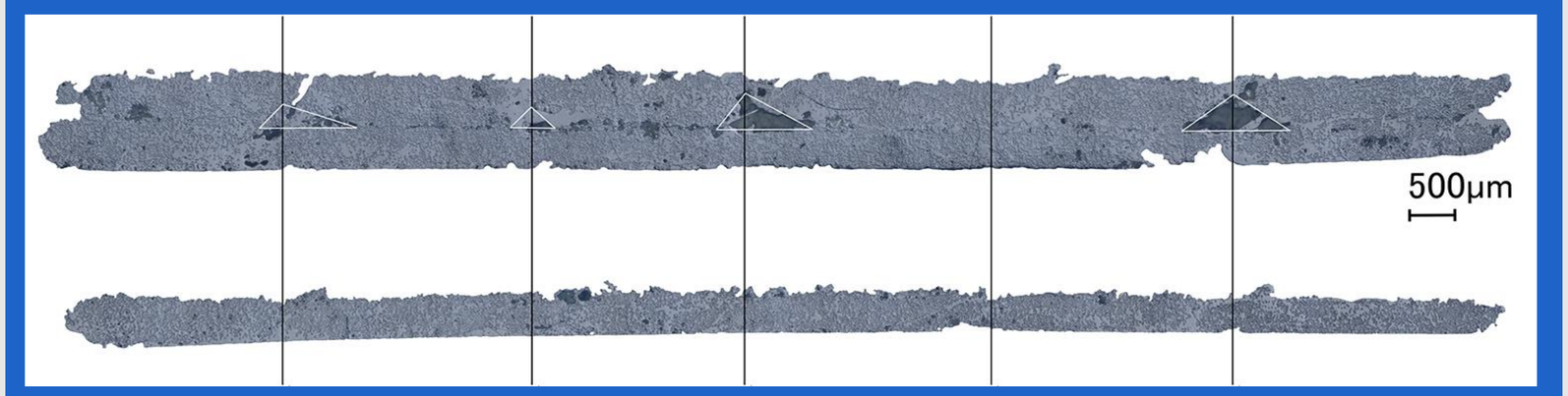

Figure 4: composite cross-section perpendicular to the fibre orientation

Outlook

Currently, the CFAM impregnation and on-line printing process is being fine-tuned for standardised samples. The samples' mechanical properties are being evaluated and compared to those of classically produced materials. In the future, 3D curved layer prints will be produced, tested and evaluated.

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