Industrialization of Additive Extrusion of endless Fiber Reinforced Structures

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About us - Institute of Composite Structures & Adaptive Systems

In a nutshell

Design and implementation of efficient lightweight solutions

Multifunctions integration for a process
• Economical
• Reliable
• User and environment friendly
• Sustainable in production and operation
About us - Our key towards efficient light weight solutions
Goals:

- Processing of high-performance thermoplastics (PEI, PEEK)
- Fibre volume content > 30%, component porosity < 2%
- Right first time approach via a digital model coupled with an online process control system
- In-Situ impregnation

Economically viable Additive manufacturing of multiscale, continuous fibre-reinforced structures via an in-situ impregnation technique.
State of the art

Continuous fiber proved as the most effective reinforcement for additive extrusion

CFF 3D printed load bearing structural part, credit: 9T-Labs

World’s first 3D-printed CFF reinforced bike frame. Credit: Arevo
State of the art – Research motivation

• Methods:
  ✓ Short or continuous fibers?
  ✓ Pre-impregnation or in-situ impregnation?

• Advantages
  ✓ Costs reduction
  ✓ Further structural optimization (Continuous Fiber Angle Topological Optimization)
  ✓ Automation
  ✓ Flexibility

World’s first 3D-printed CFF reinforced bike frame. Credit: Arevo
Our Vision – Research Outlook

Industrial-requirements driven development approach ….

Requirements collected from industrial partners belonging to multiple industrial sectors:

- Aero-space
- Automotive
- Biomedical
- Sport
- …

...to allow a successful technology transfer to the industry
Our Vision - Towards industrialization of Additive Extrusion

Willingness to cover all the process chain:

- Material development and characterization
- Design of the extrusion/impregnation devices
- Process integration
- Quality control
- Design methodology
- Simulation methodology
Results - Continuous fiber reinforcement techno-polymers
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Measure of tensile stiffness

- Pure polymer
- Polymer + Commingled Yarn
- Polymer + ‘dry’ Carbon Fiber

Measure of tensile strength

- Pure polymer
- Polymer + Commingled Yarn
- Polymer + ‘dry’ Carbon Fiber

Specimen deformation field under loading
Results - Impregnation issues

Inspections based on optical & electronic microscopes as well as computer tomography were taken at specimens inner structures.

Specimens inspections: optical microscope [Right], SEM [Right] and CT [bottom]
Results - Enhancement of In-Situ Impregnation

Effectiveness of the enhanced in situ impregnation process on a 24k roving. Without treatment [Top] with treatment [Bottom]
Results - Enhancement of In-Situ Impregnation

Effectiveness of the enhanced in situ impregnation process on a 24k roving. Without treatment [Left] with treatment [Right]
Our Vision - Industrial-requirements driven development approach to allow a successful technology transfer to the industry

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- What are the requirements for the application you have in mind?

Thank you for your attention

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