Repair 3D

Reinforced thermoplastic 3D printing from post-industrial waste streams

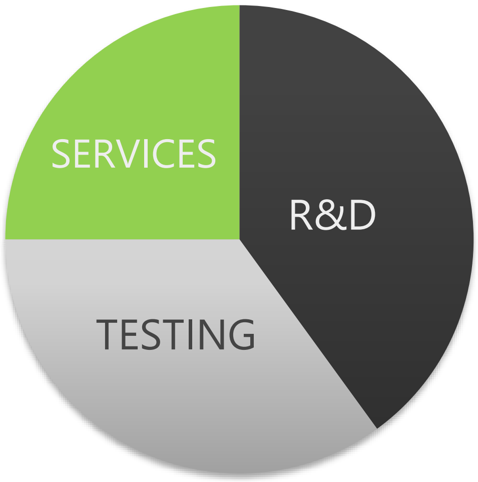
Sofie Huysman, Tom Vercoutere

CENTEXBEL

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 814588".

About Centexbel

- Collective research and technical centre in Belgium
- For the textile and plastics converting industry
- Driven by the industry
- 170 employees



Research Groups

Extrusion

Plastic processing

Textile coating & finishing

Textiles for health & safety

Biopolymers

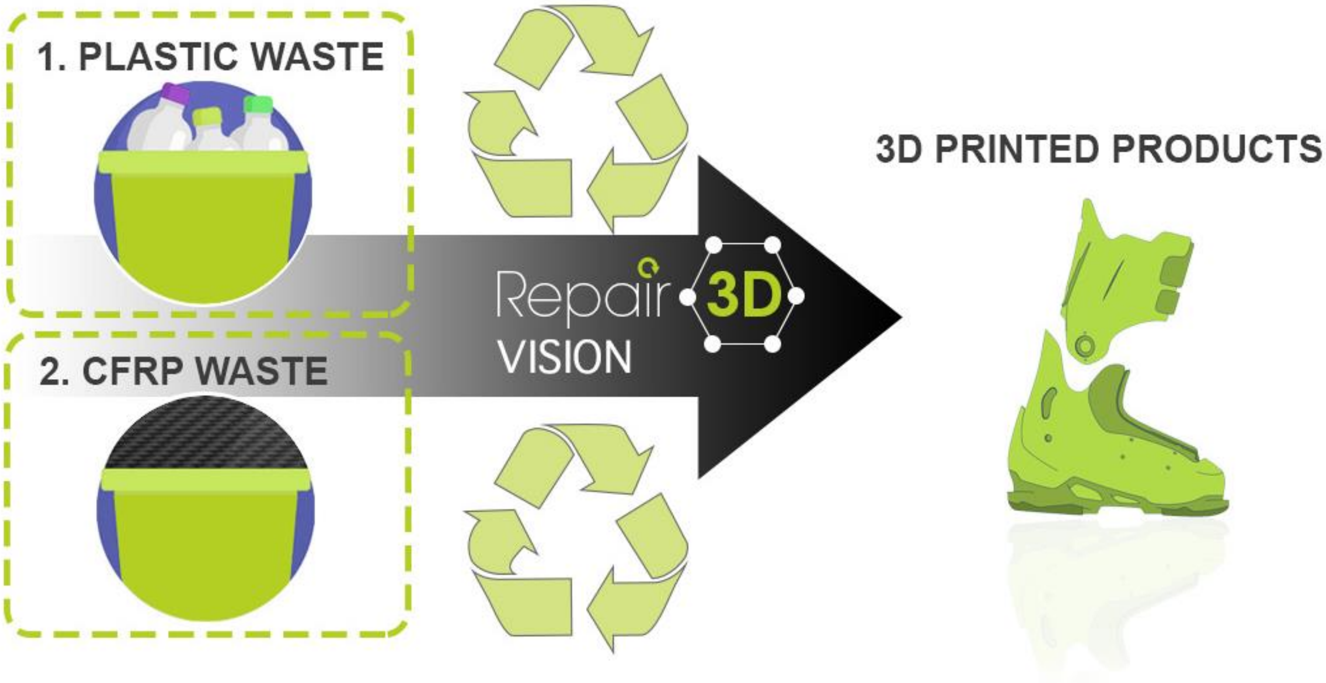
Composites

3D-printing

Recycling

Horizon 2020 project (RIA, Research and Innovation Action)

“Recycling and repurposing of plastic waste for advanced 3D-printing applications”



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International consortium of 18 partners

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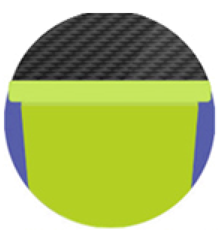
Polymer + fibres = COMPOSITE

Post-industrial plastic waste

Post-industrial carbon fiber waste



Waste from prepregs, spools, drilling, ...

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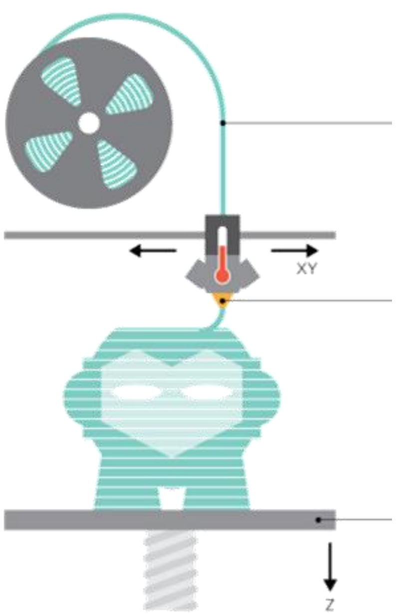
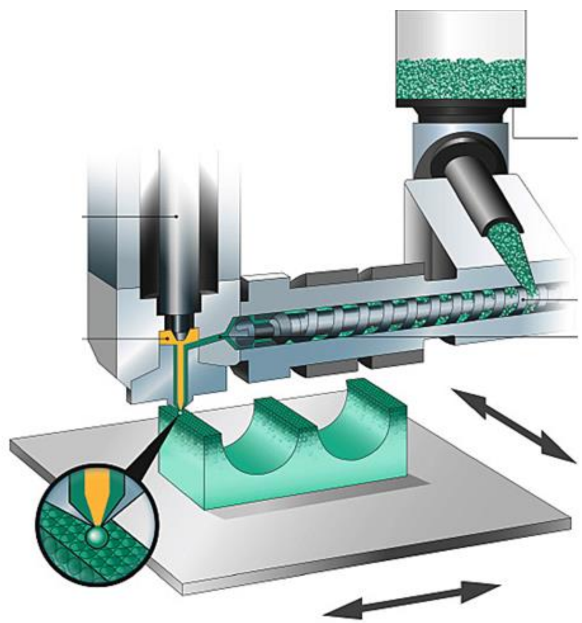
Produce materials for extrusion-based 3D-printing

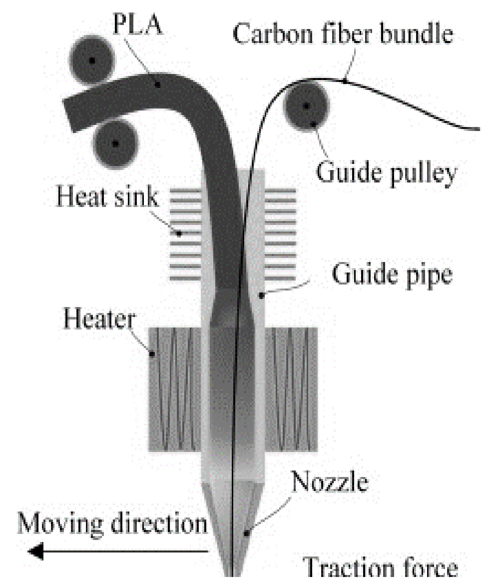
from filament



from pellets



continous fiber filament



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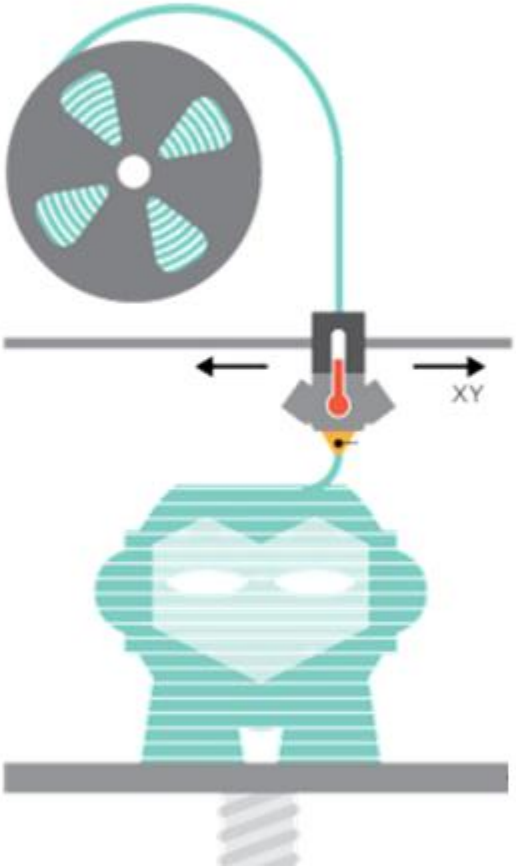
FFF = Fused Filament Fabrication

Materials should be

- extrudable into monofilaments
- flexible enough to be spooled
- not too flexible to avoid buckling



1. Filament led to extruder

2. Gear wheel controls feed
3. movement of the filament

4. Heater melts the filament

5. Nozzle extrudes the melt

6. Melt is deposited in layers

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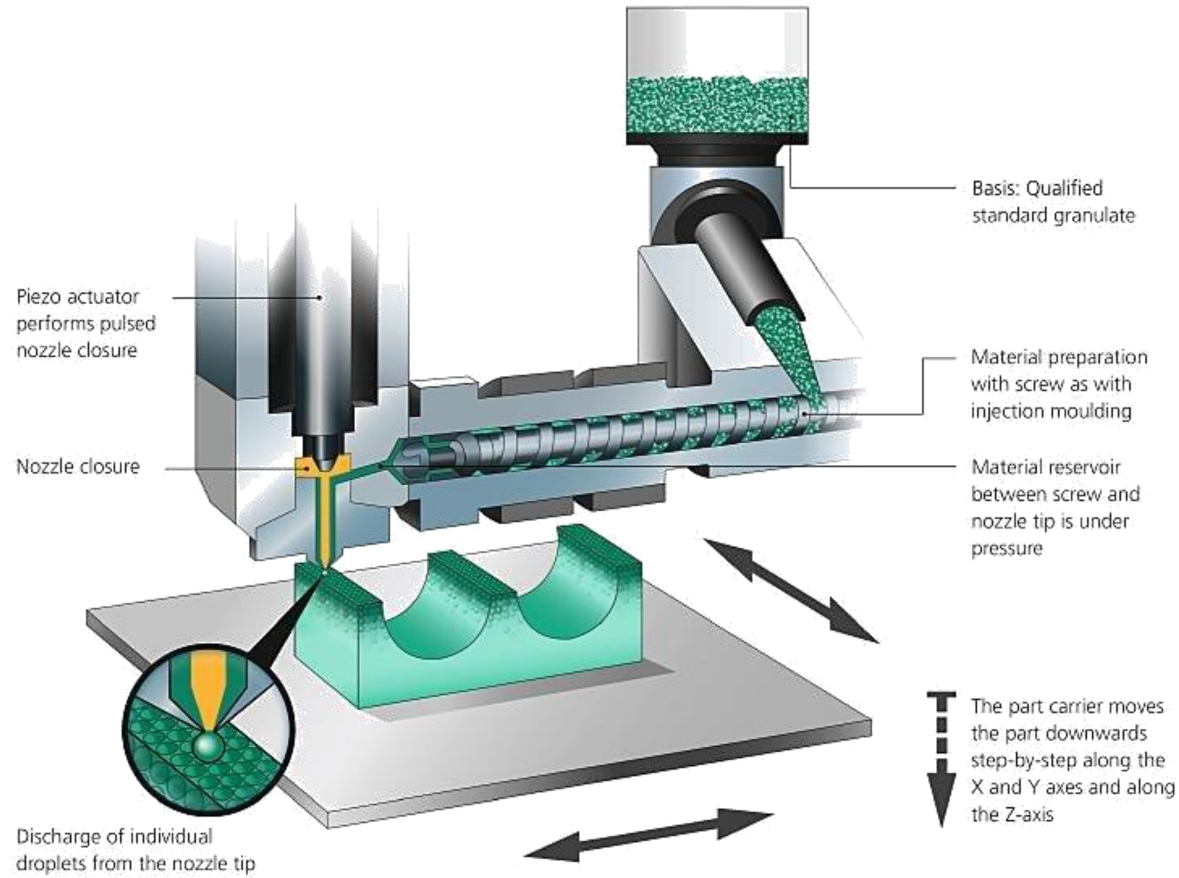
APF = Arburg Plastic Freeforming technique

Starts from pellets → less material restrictions



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Pellet 3D-printers also exist at large scale:

CEAD printer at PolyProducts

- Printvolume of 4 x 2 x 1.5 m
- Output up to 15 kg/h

Biobased fenders reinforced with hemp or flax fibres

*Part of the Interreg 2 Seas programme which is part financed by the **European Regional Development Fund***

SeaBioComp is **cofinanced** by

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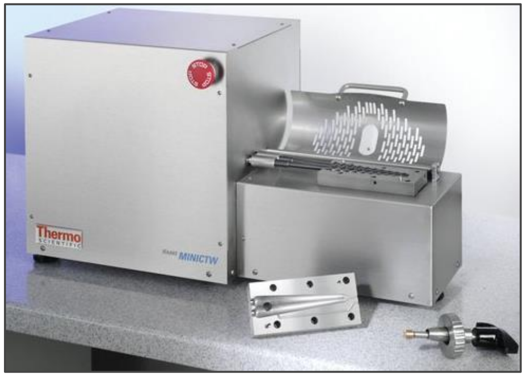
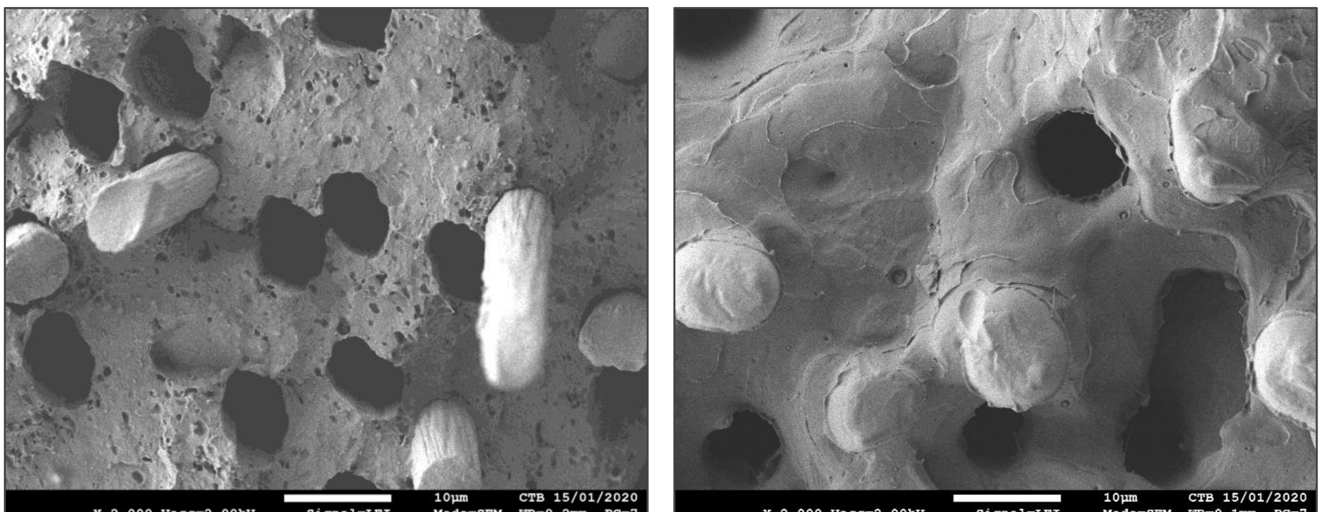


Step 1: mixing on minicompounder to evaluate adhesion between polymer & carbon fiber

Optimisation through surface treatments



Examples of weak adhesion and strong adhesion

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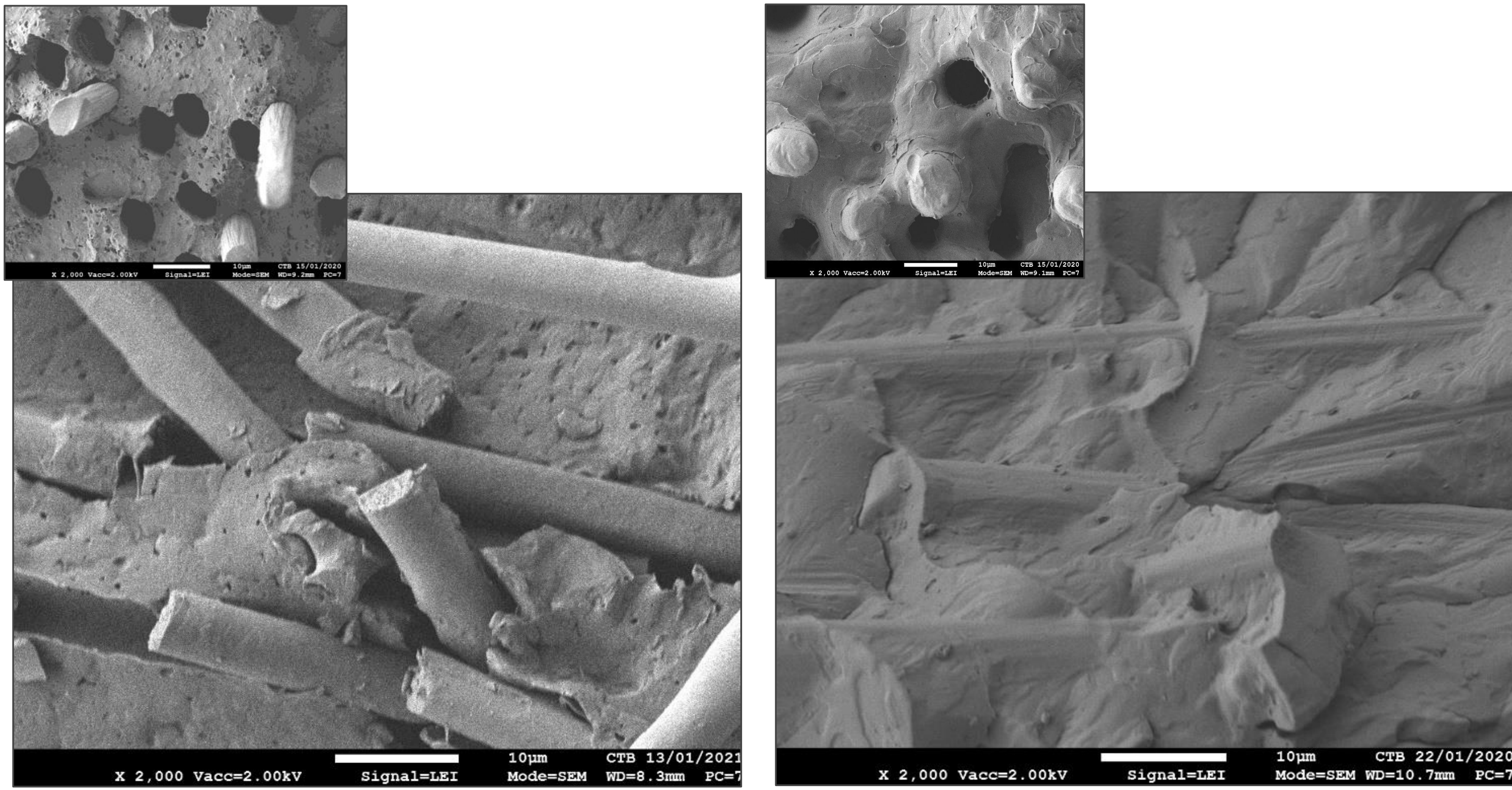

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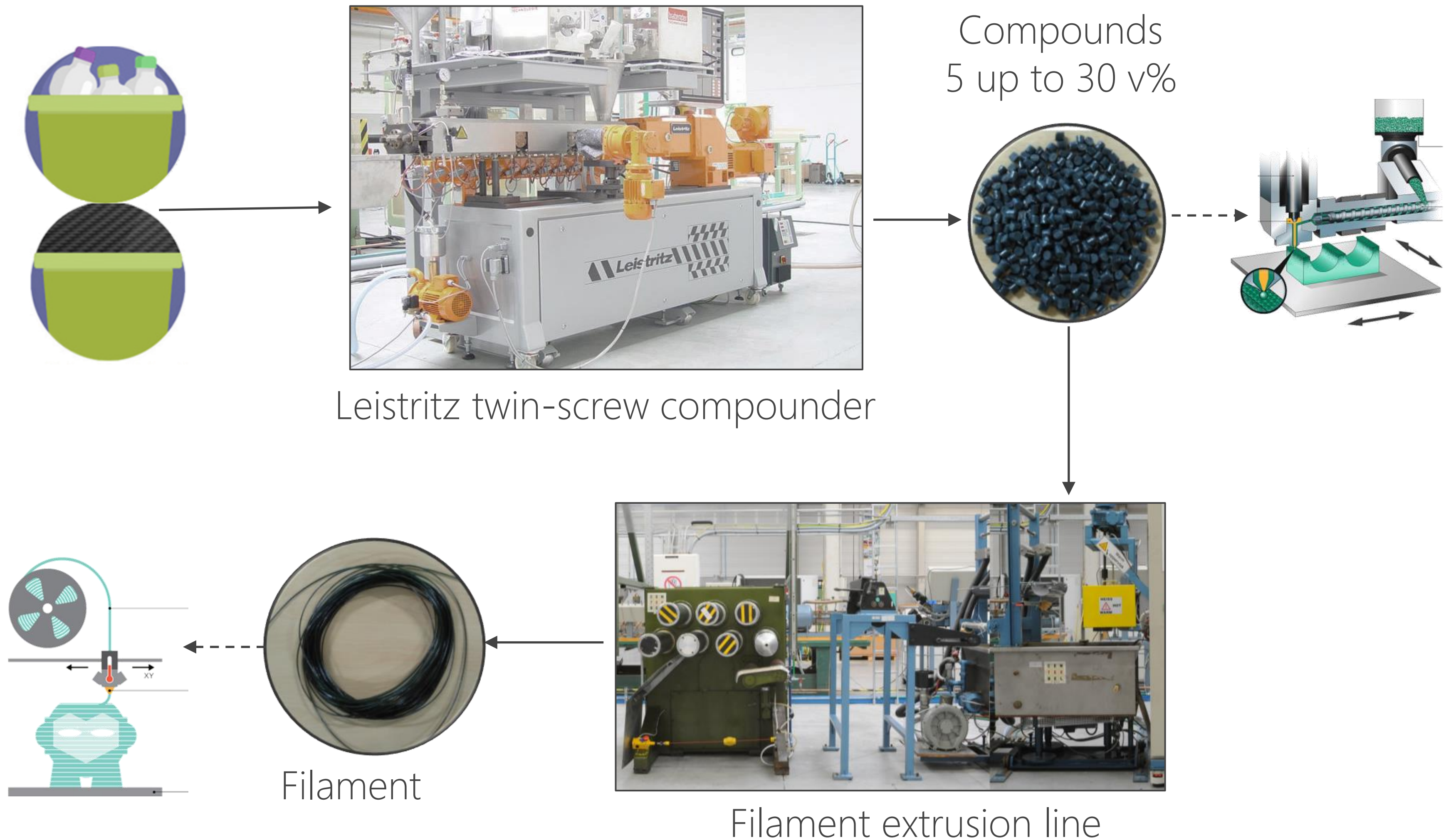

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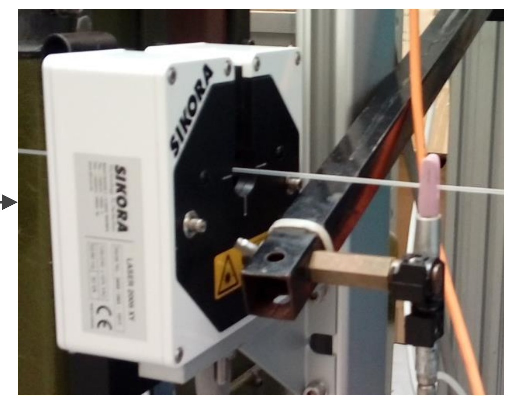

Diameter and roundness control
1.75 mm or 2.85 mm

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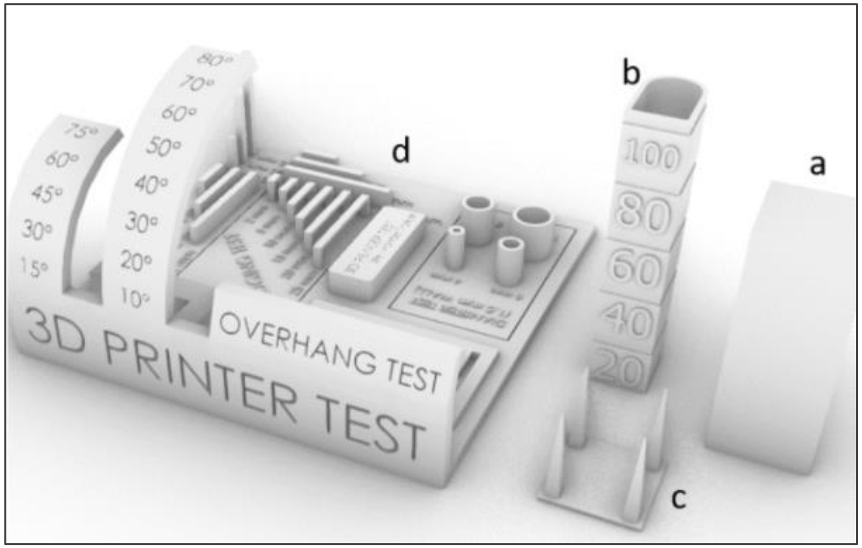
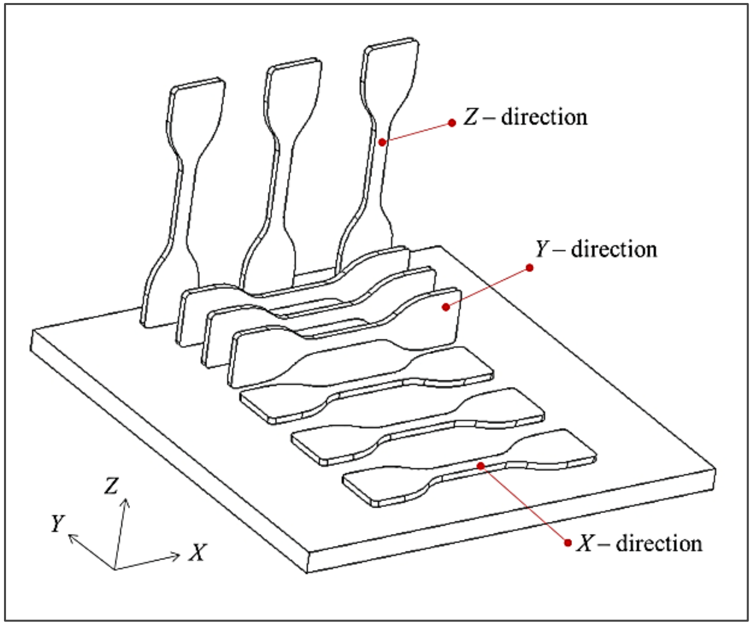


Evaluation of the 3D-printability

- Maximum % carbon fiber
- Printing temperature, speed, retraction
- Reliably printable geometrical features



Evaluation of the mechanical properties in different directions

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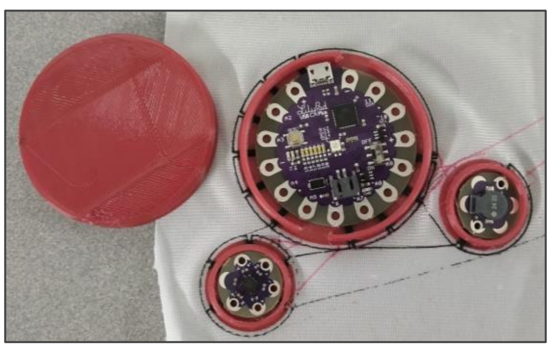
Towards 3D-printed industrial demonstrators

Ski-boot parts

interior component

fuel door component



Wearable electronics

Orthopaedic device

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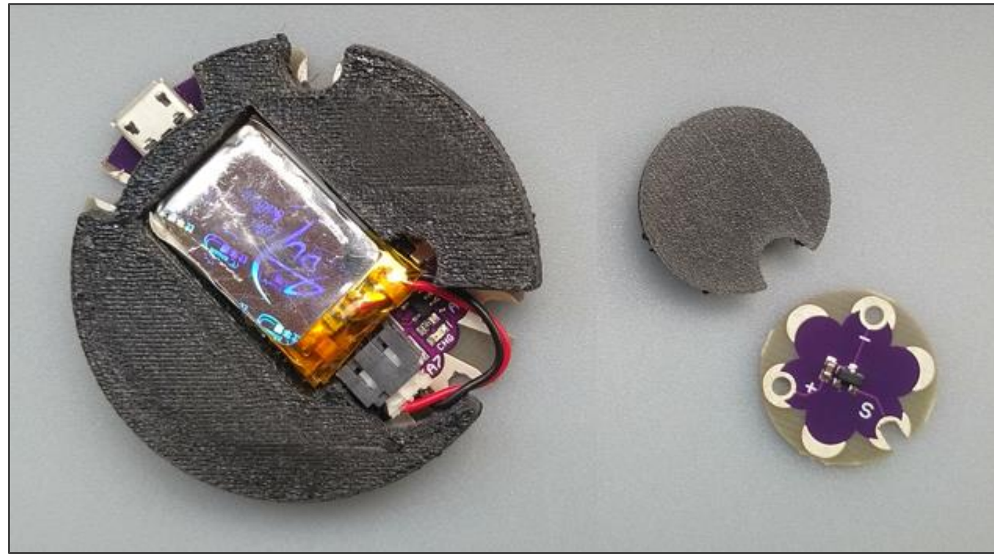
Composites in the wearable electronics demonstrator:

- Battery holder
- Sensor cover plate



Material requirement: higher stiffness than plain TPU

Final composition: rTPU reinforced with 10 m%

- **Short carbon fibers** → filament printer (Ultimaker)
- **Carbon powder** (milled fibers or drilling waste)→ pellet printer (Freeformer)

Remark: the Freeformer can only process fine powders

Large-scale pellet printers can process coarser powders and fibers

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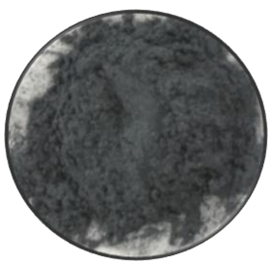
Results in the xy direction:

Short carbon fibres can already provide a significant increase in modulus (> 50%) and strength (±50%)



Carbon powders still provide a quite substantial increase in modulus (±30-50%). The increase in strength is less pronounced and depends on the size of the powder.
E.g. 100 micron is recommended over 45 micron

Powders have the benefit that they are easier to process into compounds and consequently 3D-printing materials.

based on tensile test ASTM type V

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More information on Repair3D: https://www.repair3d.net/

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