

Roboze

Roboze verso un'economia circolare

Sviluppo di materiali riciclati e bio-based
in Additive Manufacturing

Alessandra D'Anna, PhD - Roboze R&D Scientist and Compound Expert

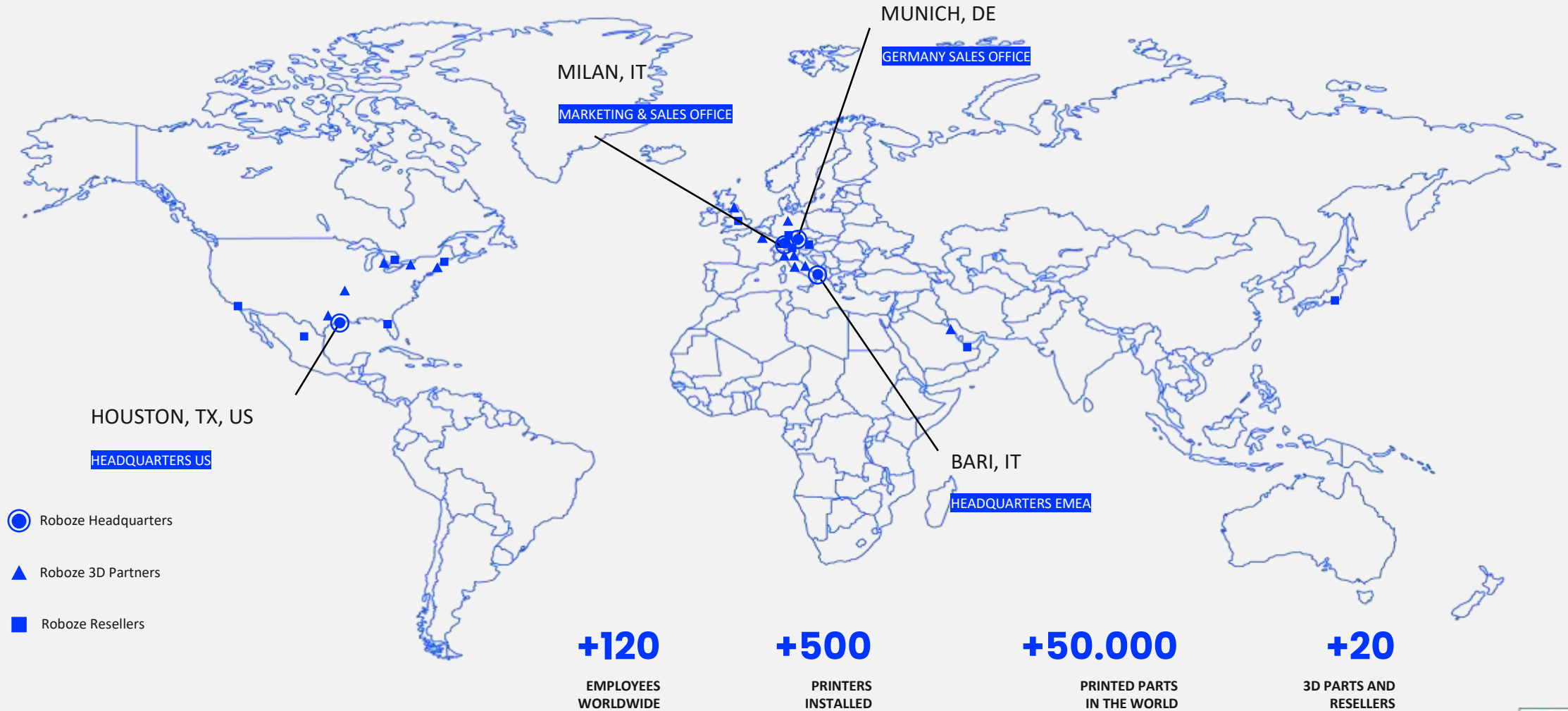
Summary

- Company overview and vision
- Sustainability: the impact of Roboze 3d Printing materials
- Bioplastics and market data
- **Roboze Bio-based PA**: characteristics and performances
- **Roboze recycled high-performance materials**: pilot plant and aim of the project
- Conclusions and future developments

Accelerating the world's transition to sustainable manufacturing



Company overview

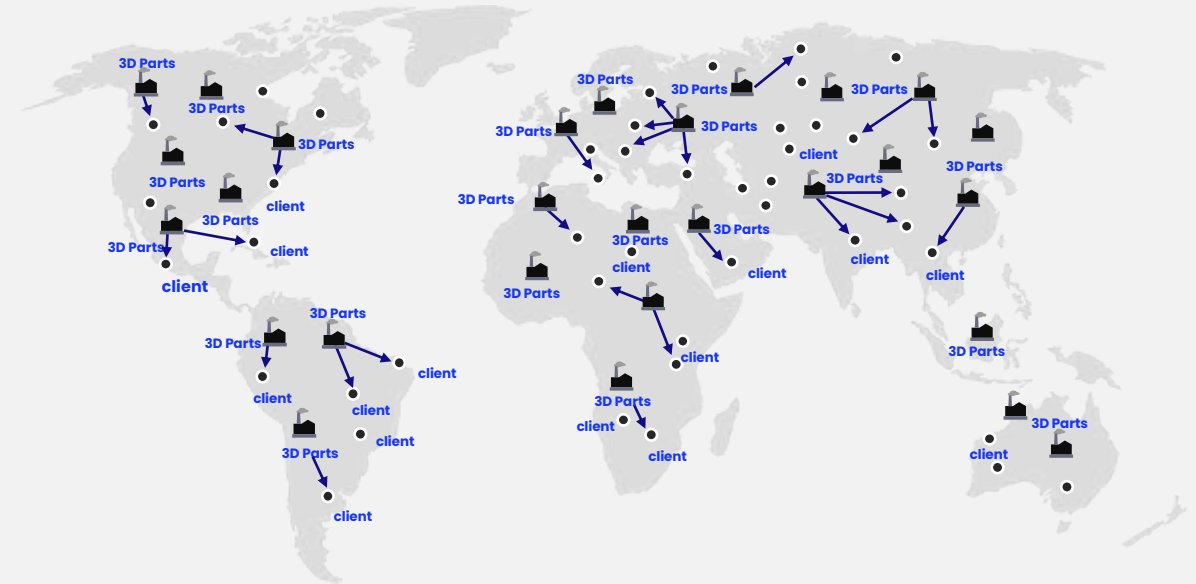
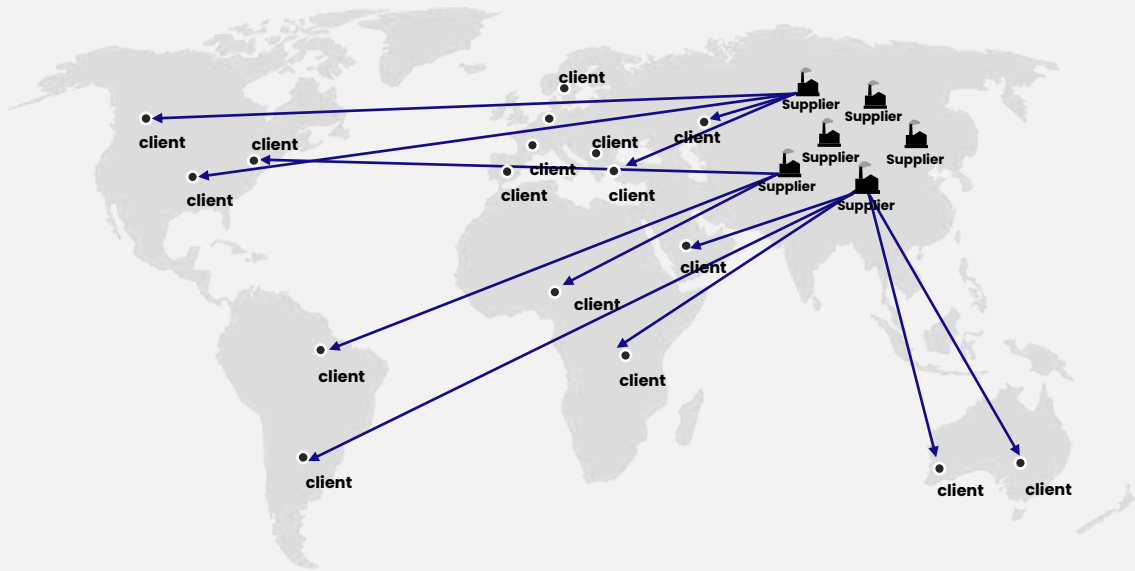


#PrintStrongLikeMetal



From Delocalized Mass Production

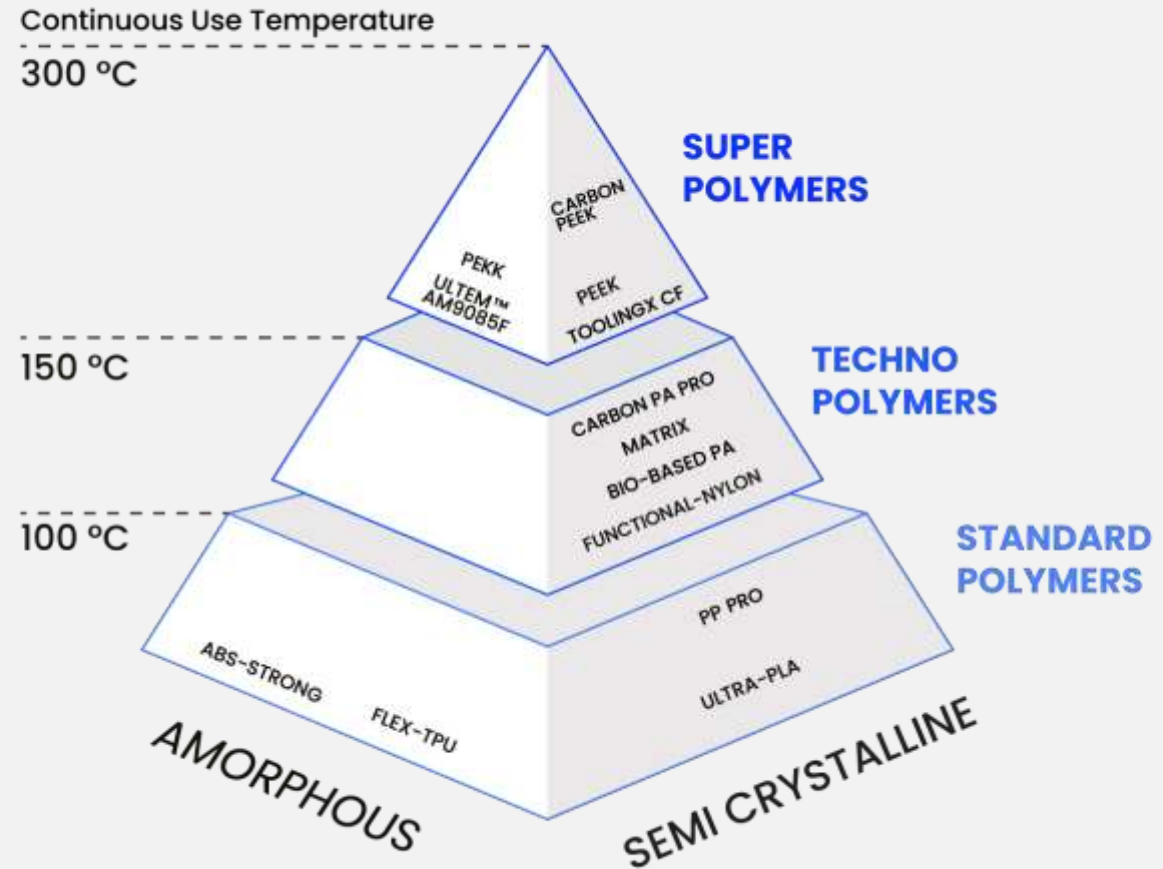
To Roboze Distributed Customized Production



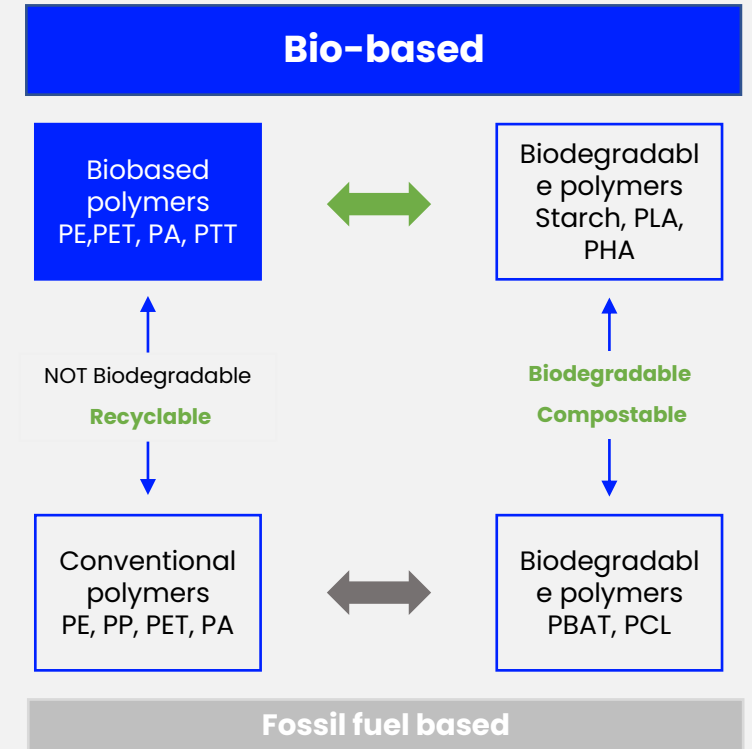
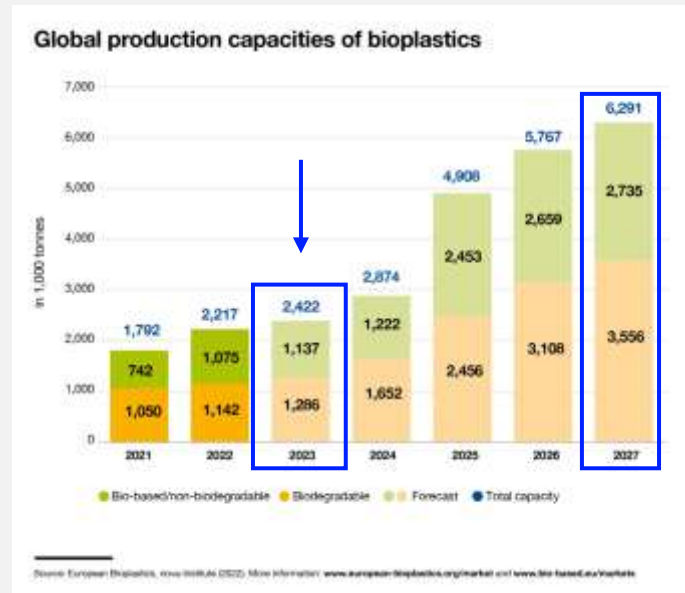
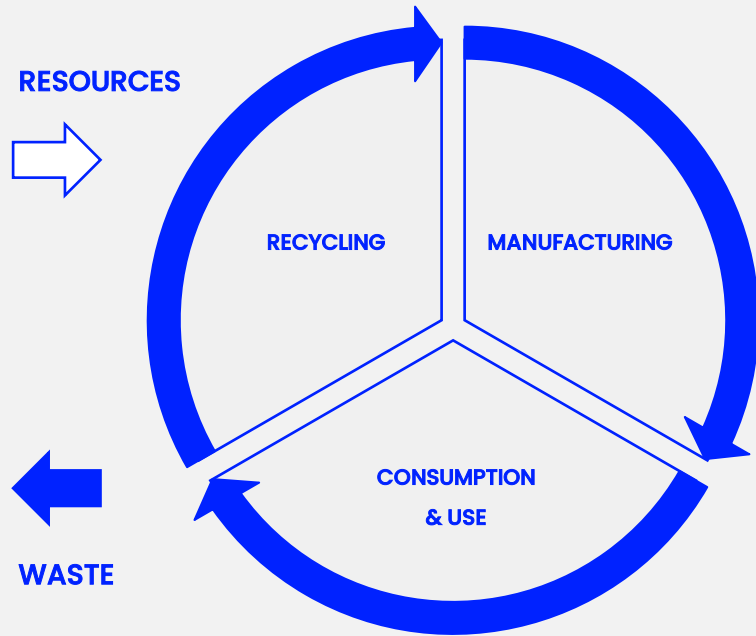
PRODUCTION RE-SHORING PLATFORM

Sustainability: the impact of Roboze 3D Printing materials

- Amorphous and semi-crystalline polymers
- **Material composites** to increase mechanical properties
- **Technopolymers** for **metal replacement**
- Design optimization and weight reduction
- High continuous use temperature



Bioplastics and market data



- Circular –economic model
- **European Parliament → zero carbon and fully circular economy by 2050**

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Roboze Bio-based PA

characteristics and performances

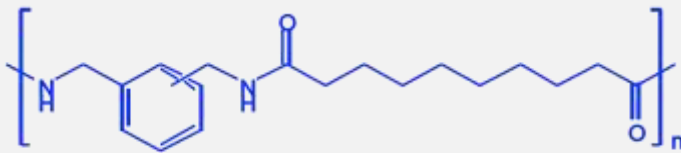
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Main features

- Reduced environmental impact



- Recyclable and bio-based PA- matrix: produced by 60% from renewable resource

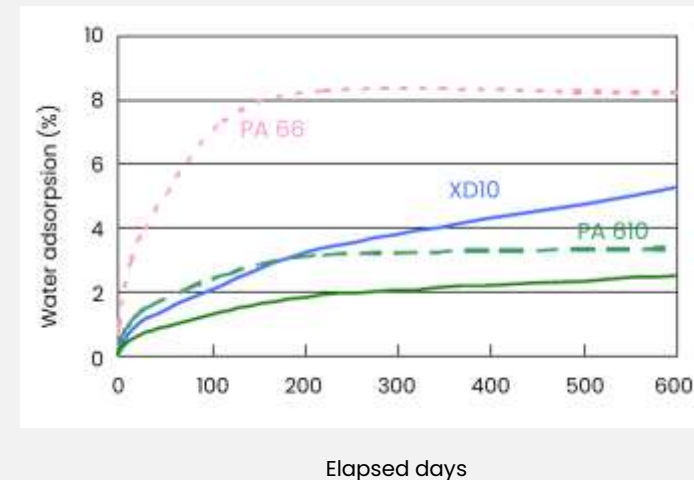


Xylylenebacamide (XD10)

- Natural cropped fibers of dimension 200 μm



- Lower water absorption than PA66



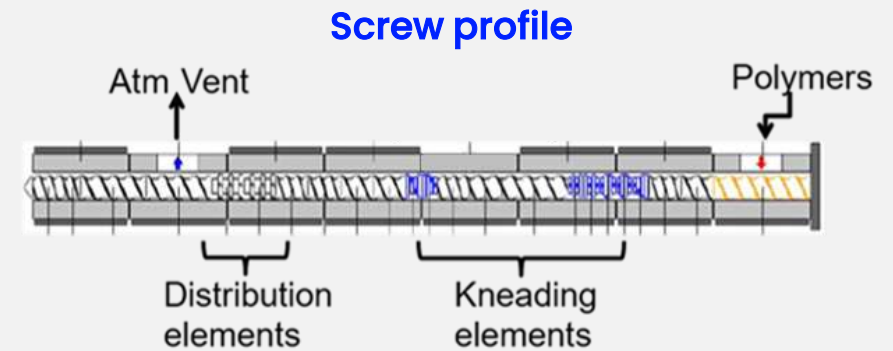
Extrusion process

Twin –screw extrusion process

- Co-rotating twin screw extruder 16mm L/D40 - Polylab HAAKE
- T profile from 220°C to 230°C
- Torque 80-90 Nm
- Pressure 3.127 MPa

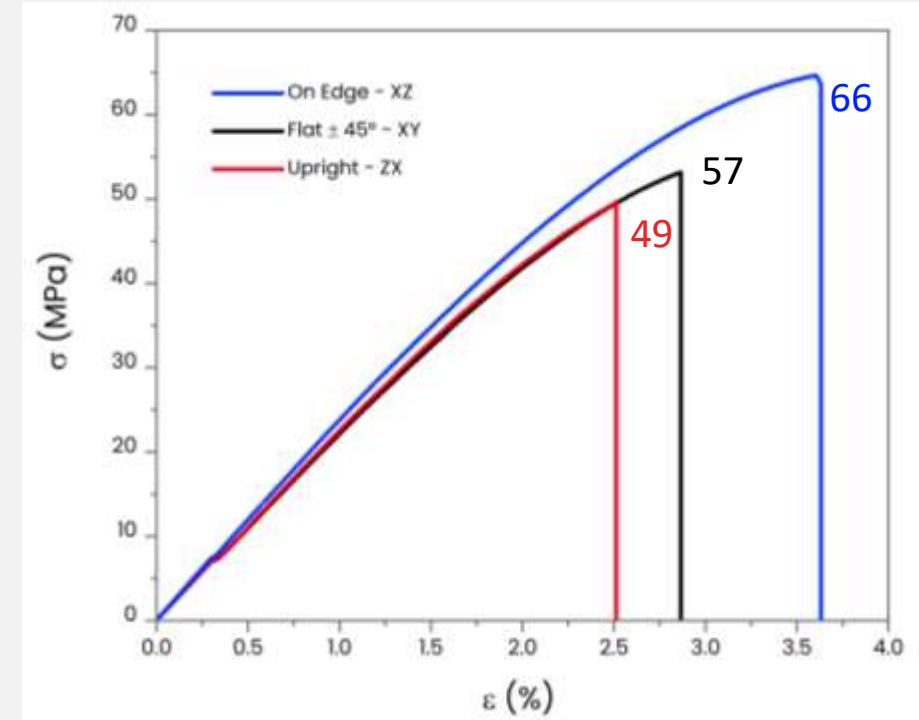
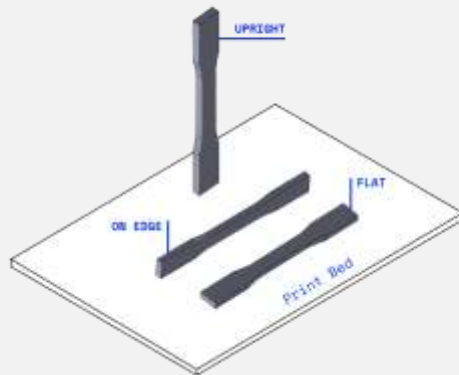
Printing parameters

- Roboze Plus PRO
- $T_{\text{printing}} = 225^{\circ}\text{C}$ and $T_{\text{buildplate}} = 80^{\circ}\text{C}$ on *buildsheet*
- Printing speed = 1800 mm/min
- Nozzle diameter = 0.6 mm (dogbones samples) and 0.4 mm

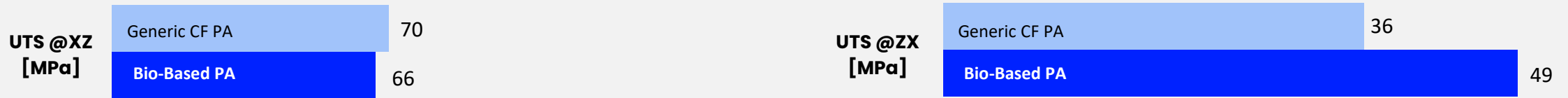


Mechanical performances

- ASTM D638 samples (all orientations)
- Young's modulus \uparrow in XZ ad XY ($\approx 2.6 \pm 0.1$ GPa)
- Young's modulus \downarrow in ZX orientation (2.2 GPa)
- Negligible warpage after print



Comparison with other materials



Near-isotropic mechanical properties

Higher layer bonding leads to a less orthotropic mechanical behavior compared to petroleum based generic carbon fiber reinforced nylon



Sustainable tooling

Wide chemical compatibility, on par with standard PA, towards oils, greases and refrigerant fluids to manufacture high performance tooling



Reduced greenhouse gas emissions

Lower emissions to produce 1kg compared to petroleum-based plastic

Applications

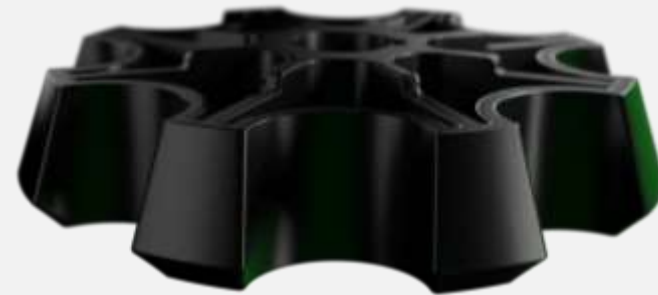
- Complex geometries
- Isotropic mechanical properties
- Lower water absorptions increased the application fields
- **Star wheel conveyors and grippers** applications

Advantages

- Wide chemical compatibility and self-lubricating
- Preservation of the mechanical properties of the parts even in case of spillage
- 60% lower carbon footprint
- Weight reduction of more than >80% possible: lighter objects reduce inertial masses



Gripping fingers in Bio-based PA



Star wheel for automated industrial lines in Bio-based PA

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Roboze recycled high-performance materials

pilot plant and aim of the project

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Mechanical recycling process

- **Circular economy plan**
- Mechanical recycling of high performances polymers
- *Use of flakes in FGF technology and Roboze ARGO 1000 HYPERMELT*



Granulation pilot plant



Recycling process

Roboze extruder for FGF technology

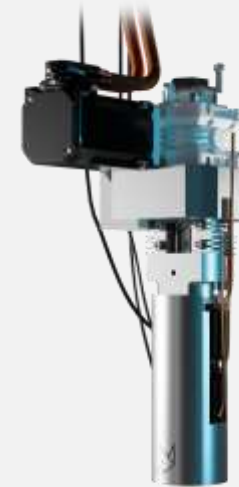
Fused Granular Fabrication technology

- Up to 10x print speed
- Up to 3x cost saving
- Higher filler content, for higher in-plane mechanical performances
- Uniform melt temperature distribution, for higher out-of-plane mechanical performances

When compared to equivalent FFF process.

Roboze BNT extruder

- Extrusion rate up to 2 Kg/h
- Maximum operating temperature 450°C, 3 separated heating zones
- Nozzle sizes range 0.8mm-3 mm



FGF Roboze extruder



Roboze ARGO 1000 HYPERMELT

Printing and mechanical properties results of r-materials

- Validation of r-materials: r-PEEK, r-ULTEM™ 9085, r-Carbon PA, r-Carbon PEEK
- Mechanical properties : Young's modulus, Tensile Strength, Elongation at maximum load ASTM D638

Materials	Young's modulus [GPa]	Tensile Strength [MPa]	Elongation at maximum load [%]
r-PEEK	≈	≈	+ 11
r-ULTEM™ 9085	≈	≈	+ 13

≈ : as compared to the virgin polymers
All the mechanical tests are in process of validation



r-PEEK flakes

Conclusions and future developments

Roboze Bio-based PA

- First bio-based PA reinforced with natural fibers with comparable mechanical properties of fossil-fuel based PA
- Quasi - isotropic behaviour
- Good processability during compounding and printing processes
- Wide application fields

Roboze recycled high-performance materials

- Circular economy plan
- Evaluation of LCA of the process and the materials (*in progress*)
- Evaluation of the carbon footprint of the recycled materials (*in progress*)

BARI, IT

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