

# Microengineered hybrid fibers for large composite structures

Frontiers in Energy Research  
11th of May 2021  
Nicole Aegerter

# Fiber reinforced composites

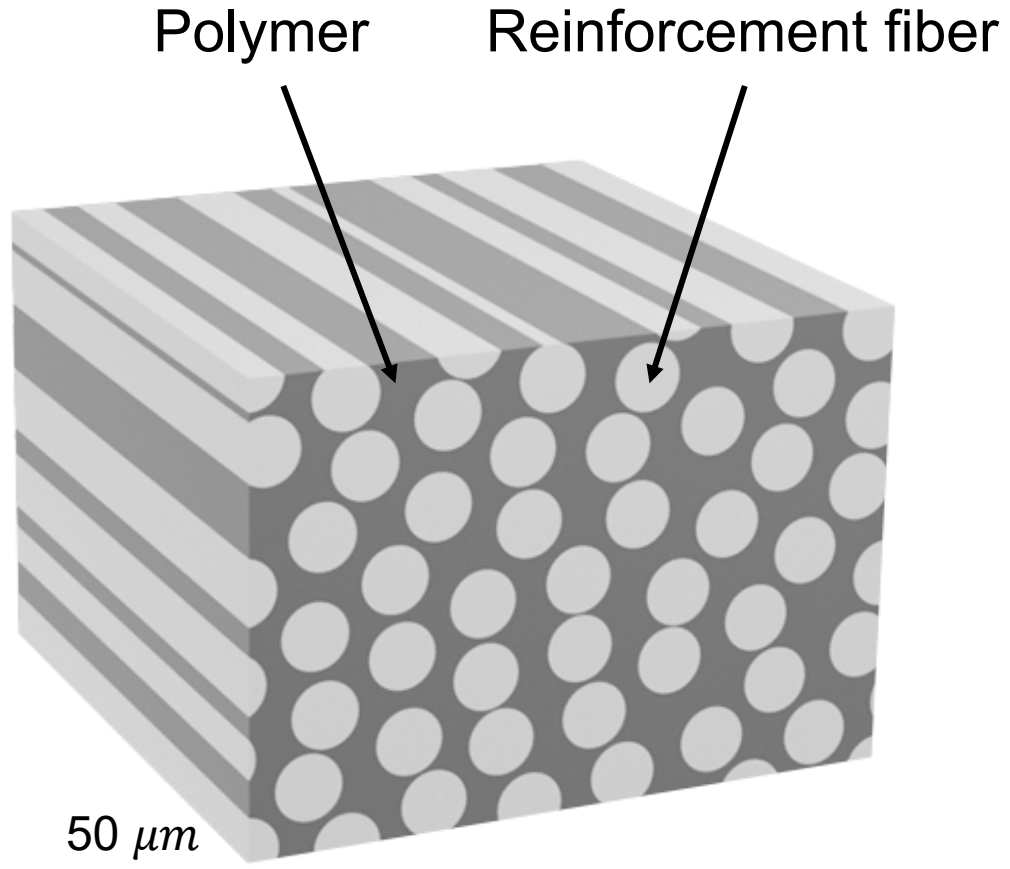
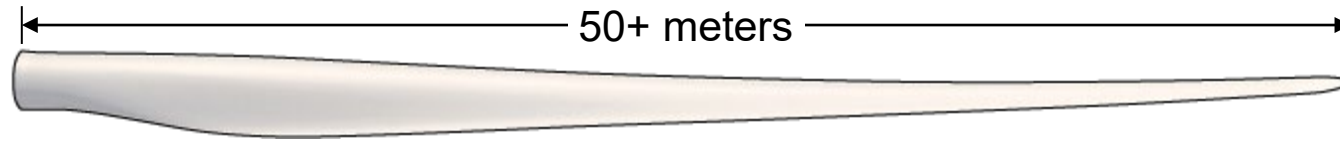


Image source: C. Schneeberger

- Lightweight material from
  - Strong reinforcement fiber
  - Light polymer
- State-of-the art manufacturing:  
Impregnation of fibers with resin



# Problem of wind turbine blade manufacturing



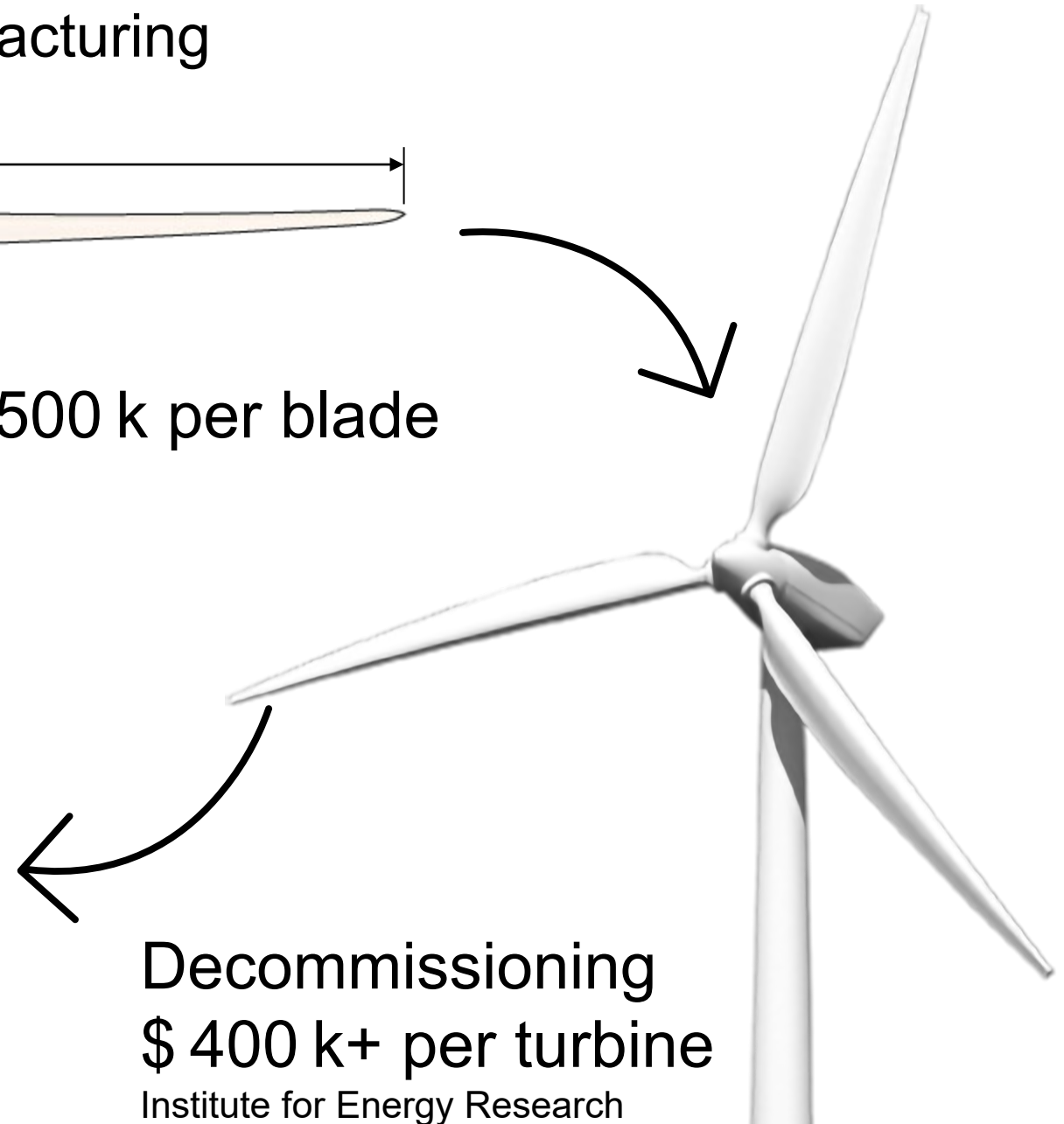
## Production

≥1 day cycle time, \$ 150 k-500 k per blade

Sandia National Laboratories, TPI Composites



Casper Regional Landfill, Wyoming, USA  
Photo: B. Rasmussen for Bloomberg Green



Decommissioning  
\$ 400 k+ per turbine  
Institute for Energy Research

# Problem in automotive industry

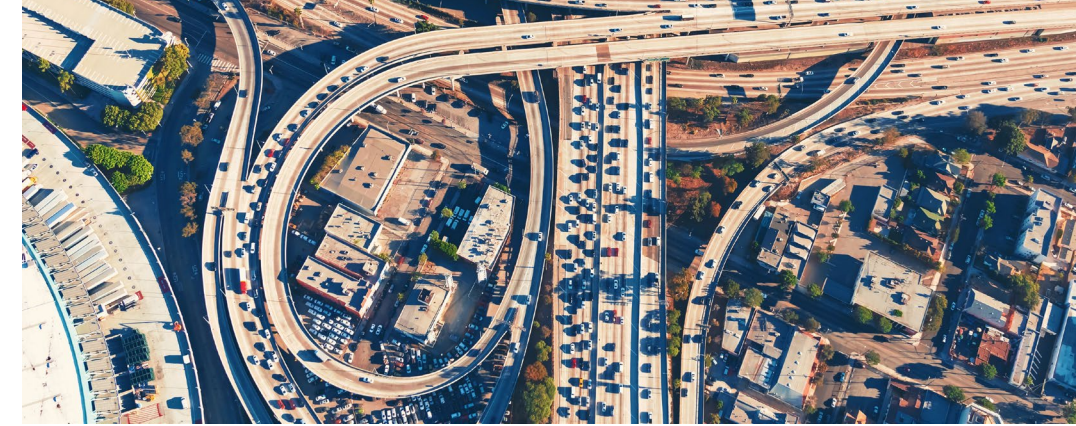
High-volumes necessary  
e.g. 6'000 Tesla Model 3 per  
week produced (2018)

Tesla Q2 2018 Vehicle Production and Deliveries



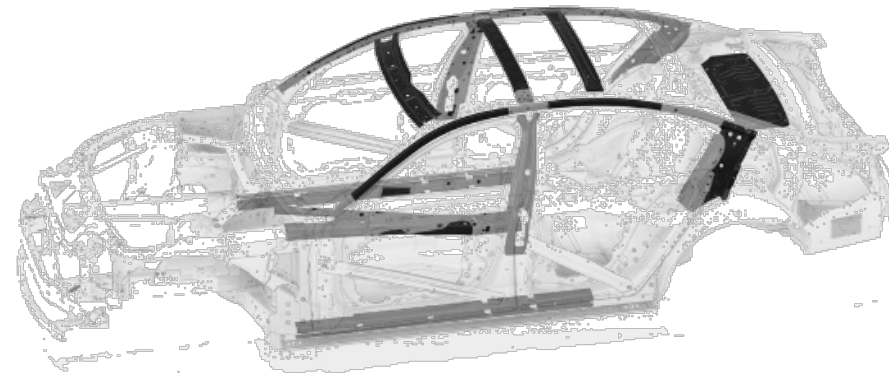
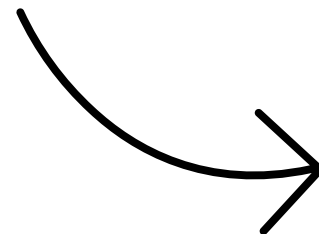
# Transport contributes to ~30% of GHG emissions in CH (2016)

Swiss Federal Office for the Environment FOEN

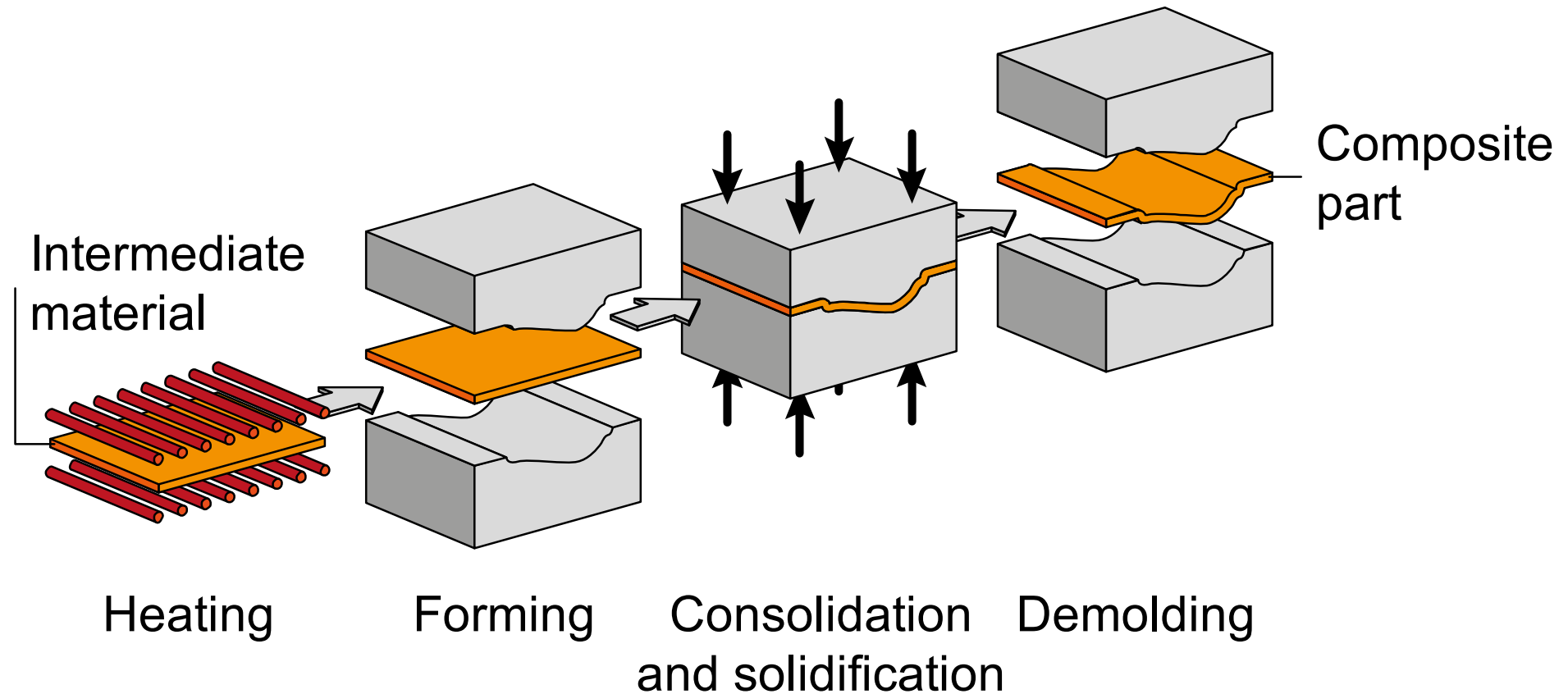


# CO<sub>2</sub> reduction in use up to 13% with lightweight materials

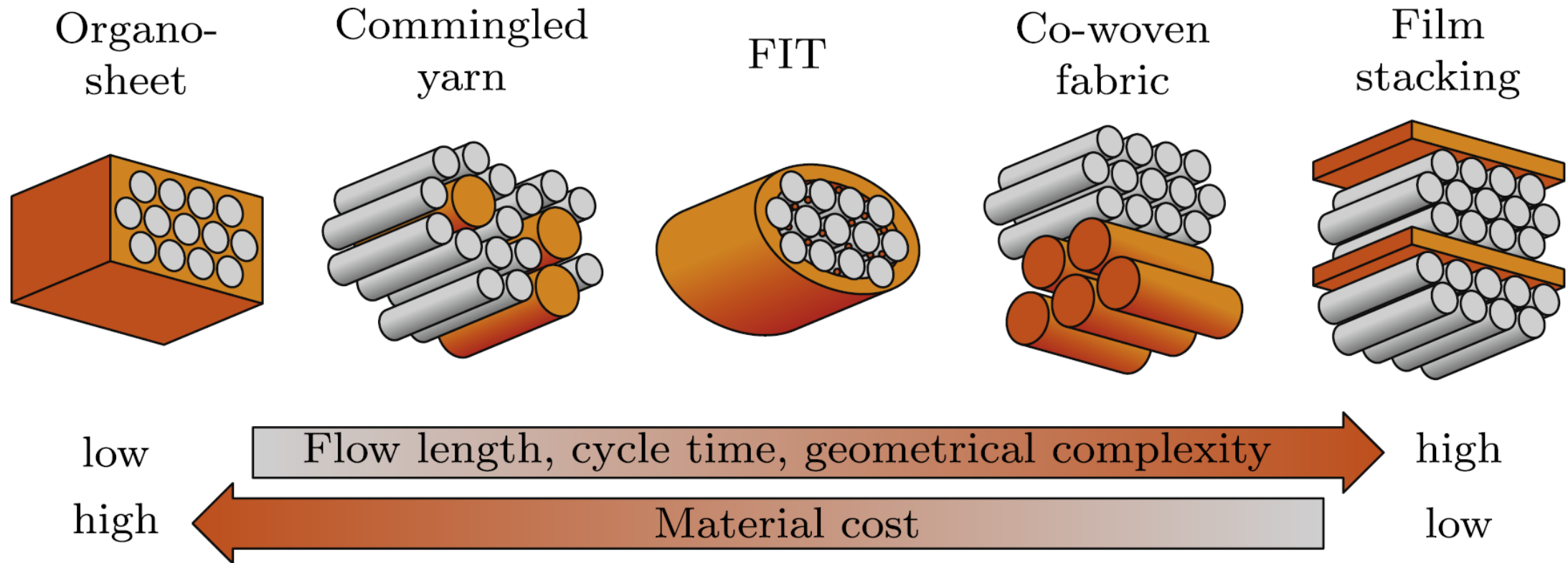
SCCER Mobility White Paper 2017



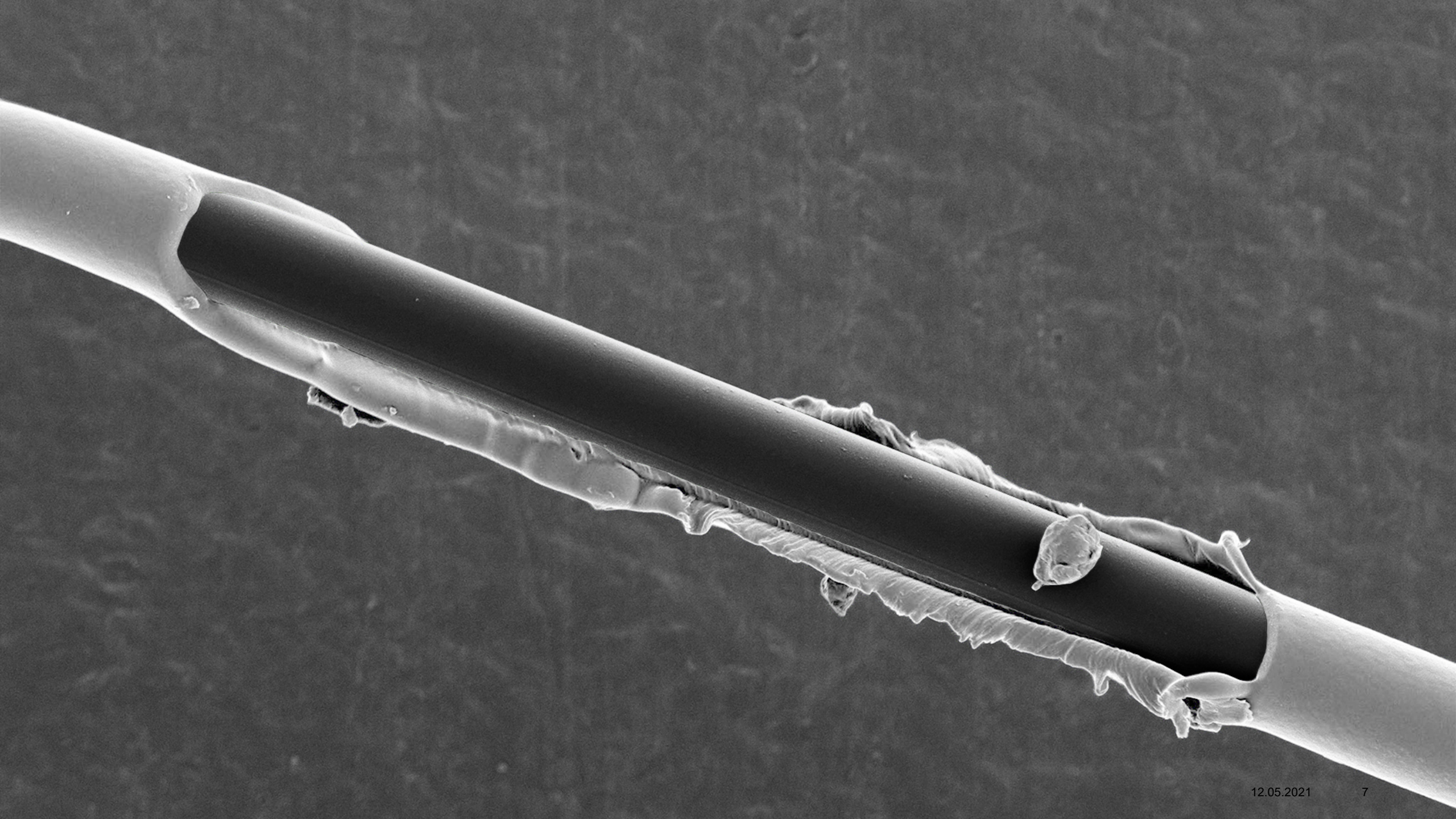
# Rapid stamp forming of thermoplastic intermediate materials



# Thermoplastic composite intermediate materials



Source: C. Schneeberger, J. C. H. Wong, and P. Ermanni. Hybrid bicomponent fibres for thermoplastic composite preforms. *Compos. Part A Appl. Sci. Manuf.* 103, 69–73 (2017).



# The advantage of microengineered fibers

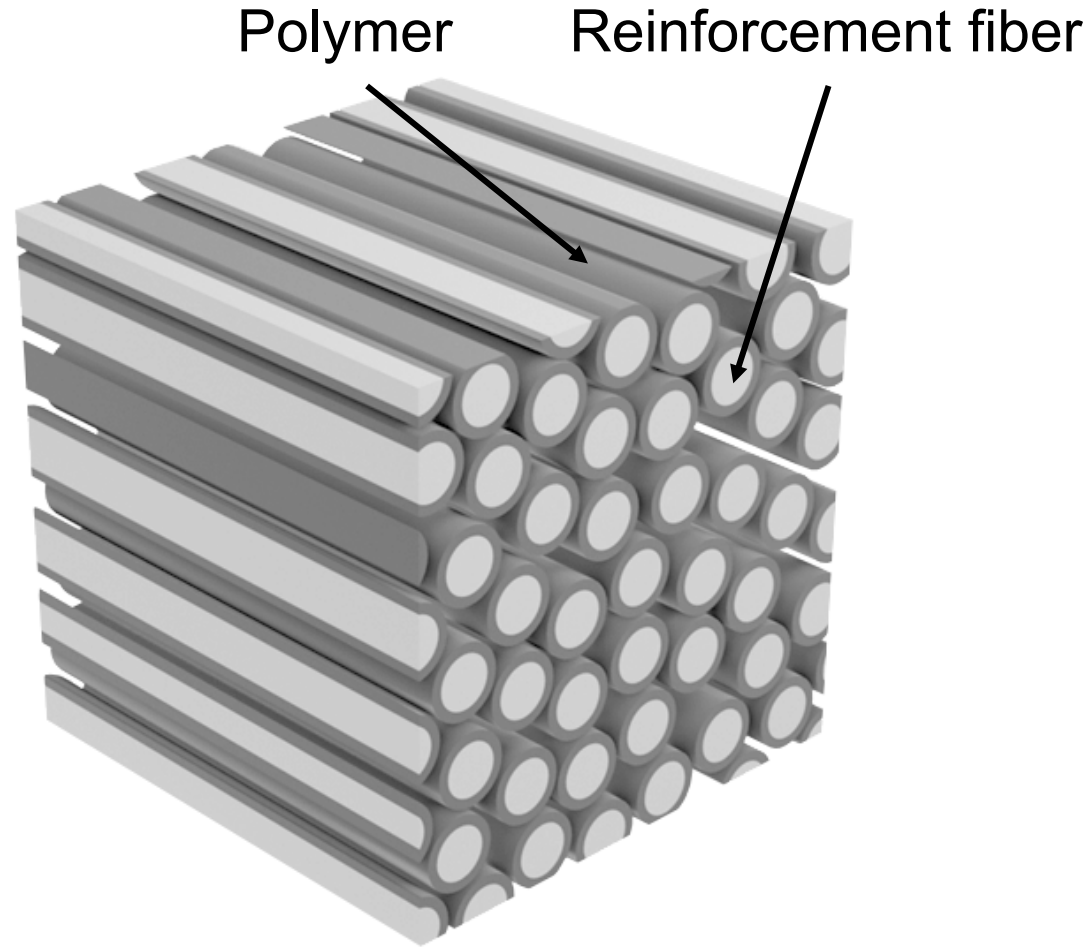


Image source: C. Schneeberger



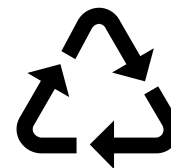
Low cycle time  
no impregnation  
no curing



Superior quality  
uniform fibre distribution  
drapable



Forming and re-  
forming

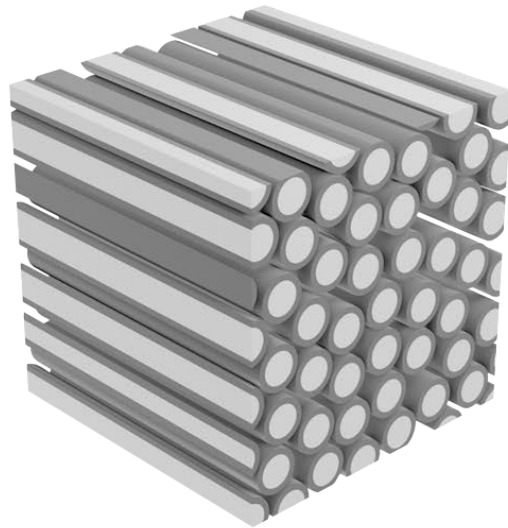


Can be recycled

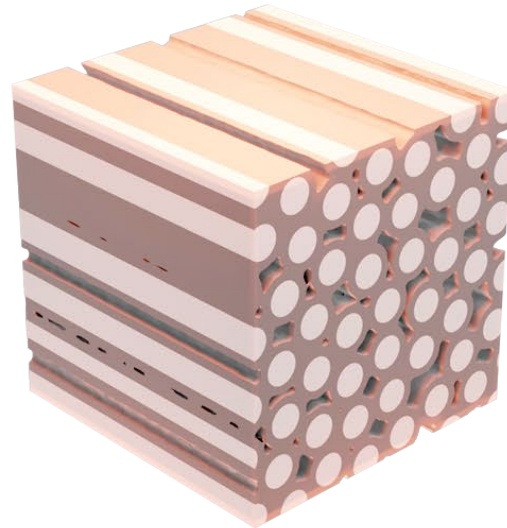


# Consolidation into solid parts

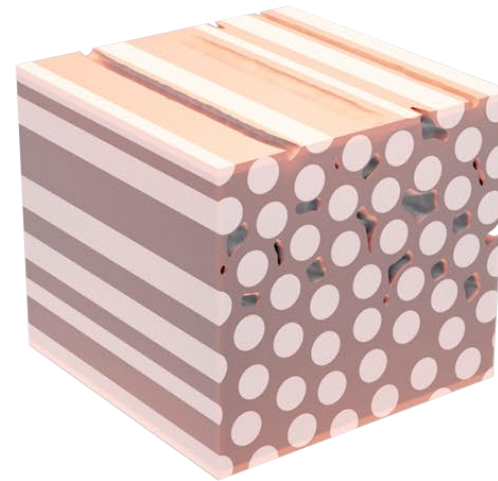
Dry fabric



+ Heat



+ Pressure



Consolidated part

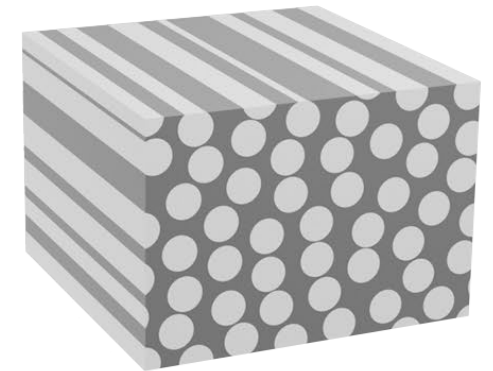
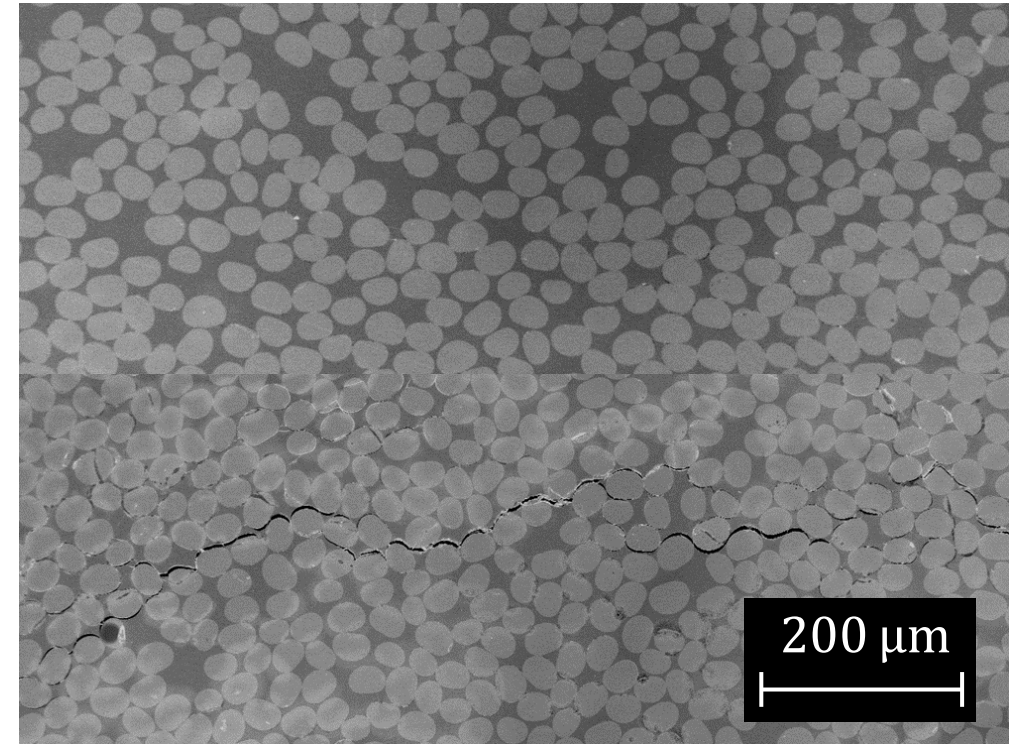
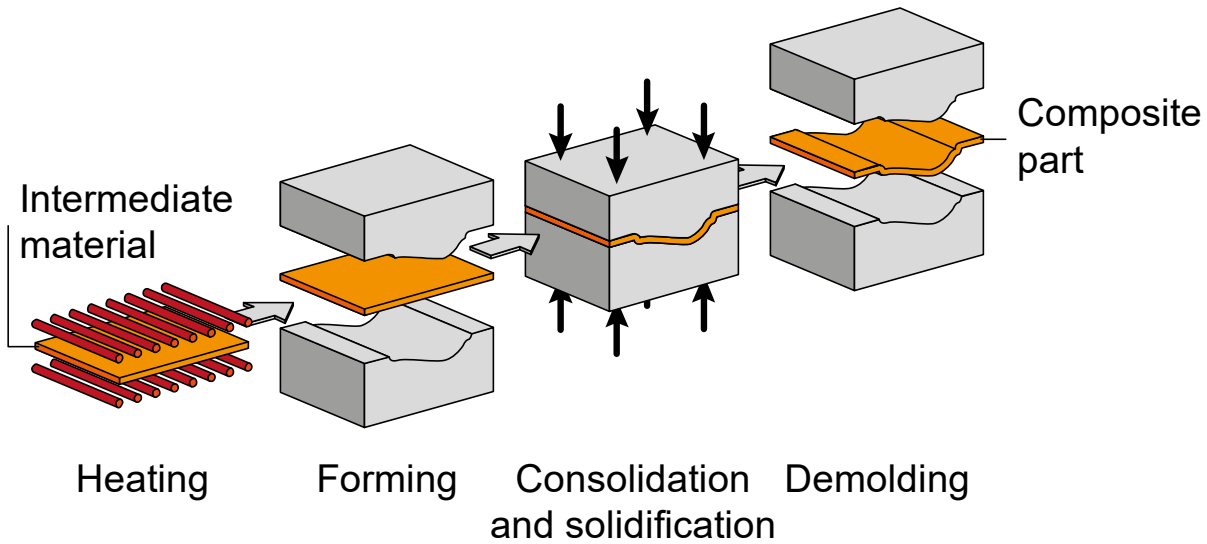
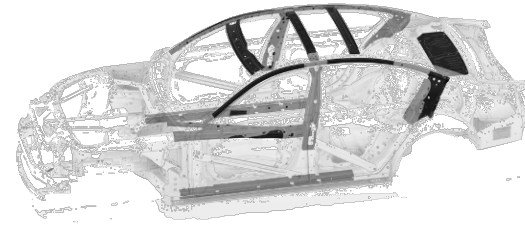


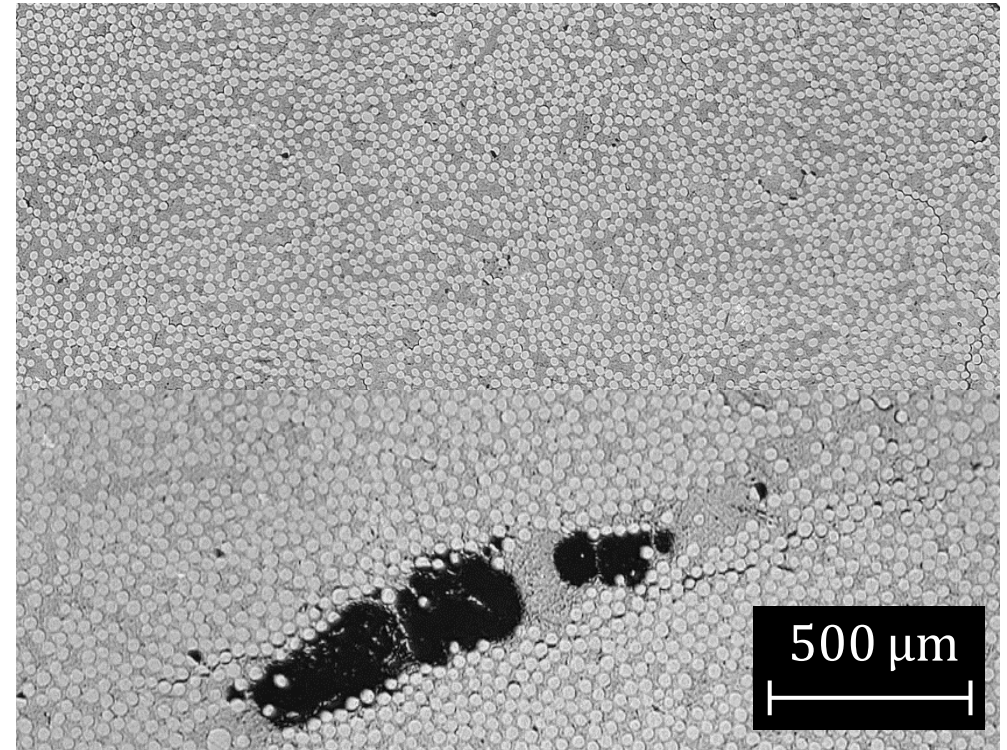
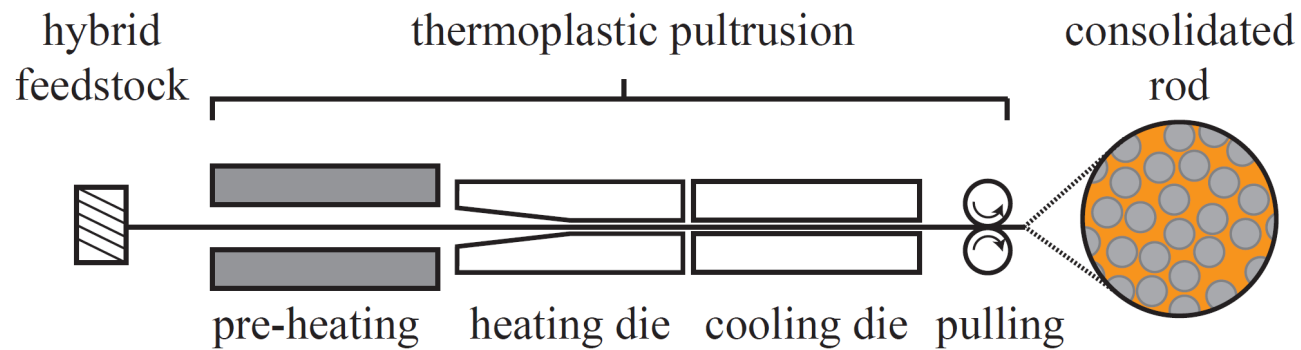
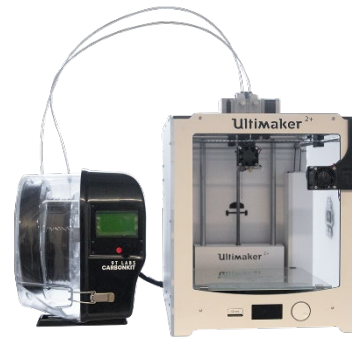
Image source: C. Schneeberger

# High-volume rapid stamp forming



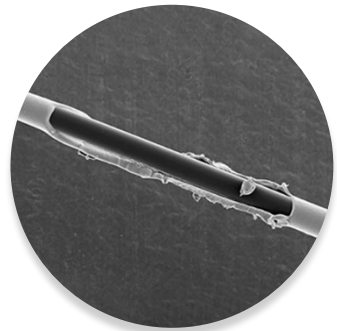
C. Schneeberger, N. Aegerter, S. Birk, S. Arreguin, J. C. H. Wong, and P. Ermanni, "Direct Stamp Forming of Flexible Hybrid Fibre Preforms for Thermoplastic Composites," in *SAMPE Europe Conference 2020*.

# Pultrusion of constant profiles



N. Aegerter, M. Volk, C. Maio, C. Schneeberger and P. Ermanni, "Pultrusion of hybrid bicomponent fibers for 3D printing of continuous fiber reinforced thermoplastics ". *Preprint submitted to Advanced Industrial and Engineering Polymer Research*

# Antefil Composite Tech – Microengineered hybrid fibers for high-volume production



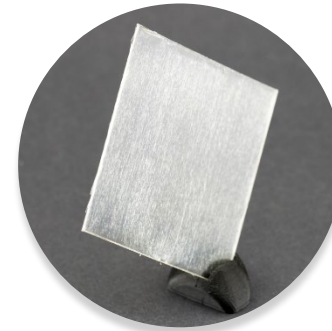
First fibers

2016



Prototype plant

2018



Proof of Concept

2020



Scaled production

2022

proudly supported by



# Acknowledgments

## Research by

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[www.structures.ethz.ch](http://www.structures.ethz.ch)

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