

Thermoplastic composite pultrusion

Dr. Anatole Gilliot

SUPREM

Thermoplastic composite pultrusion

- Suprem's expertise
- Thermoplastic vs. Thermoset
- Thermoplastic + Continuous fibre
- Challenges
- Applications
- Conclusion



Suprem's expertise

Technological SME located in Switzerland

Owned by Swiss **industrial investor**

30 years of **experience** in thermoplastic composite materials

ISO 9001:2015 and ISO 13485:2016 **certified**

Qualified for Aerospace, Oil & Gas and Medical application

- Flexibility & reactivity
- Investment / growth capability
- Long-term thinking

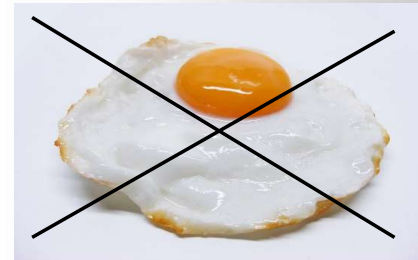
suprem

Pultrusion Conference 2021

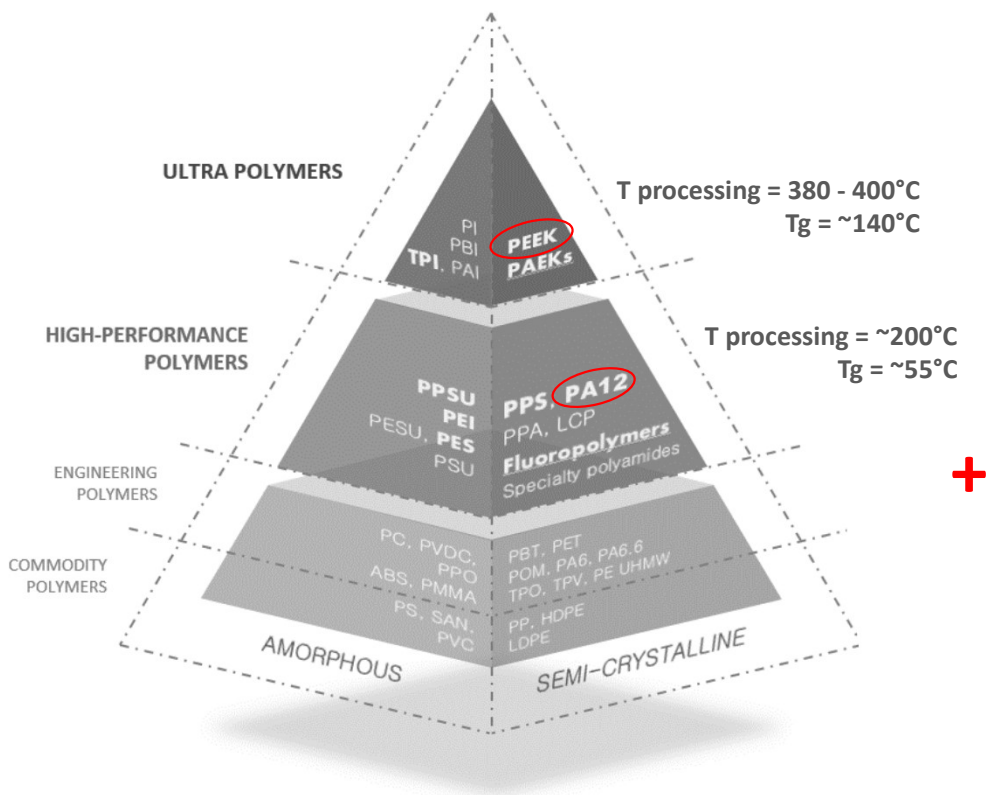


Thermoplastic vs. Thermoset

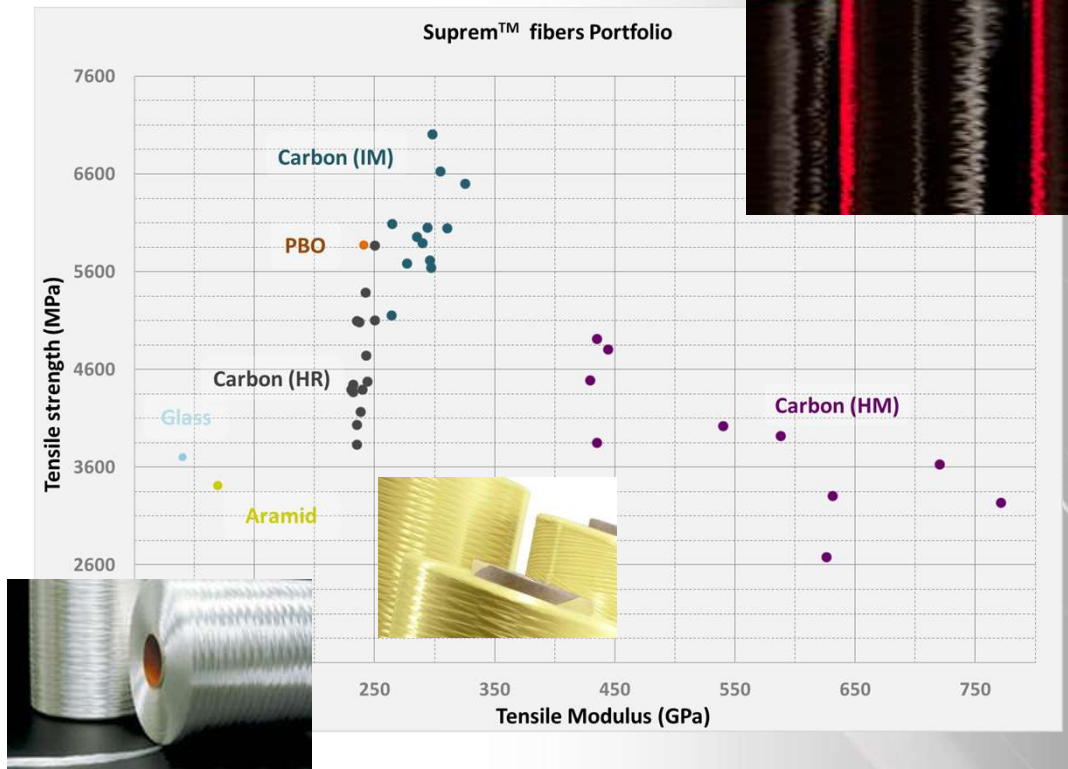
- Room temperature storable / shipment
 - Clean process (no “sticky” workshop)
 - Shape-able (heat, pressure, time)
 - Re-formed / Re-usable / Recyclable
 - Good resistance to aggressive fluids
 - Good temperature resistance
-
- Elevated processing temperature
 - High viscosity



Thermoplastic + Continuous fibre

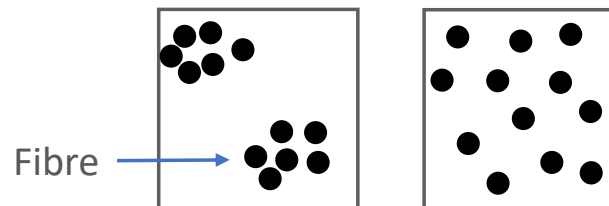


+

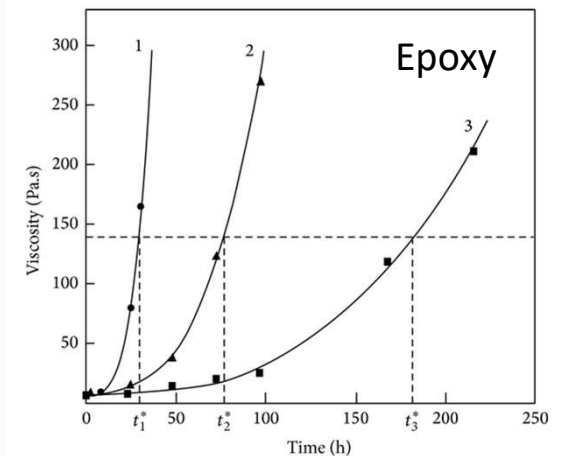
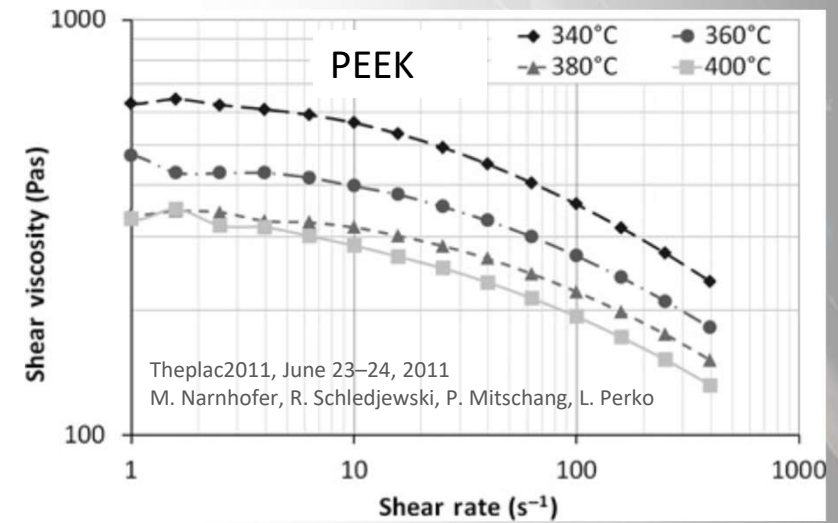


Challenges

- Pultrusion of fibre with thermoplastic
 - Elevated processing temperature (200-400°C)
 - High viscosity at processing temperature
 - PEEK: ~300 Pa.s (at 400°C)
 - Epoxy: ~0.1-10 Pa.s (at 20-120°C)
 - Fibre wet-out and disruption of unidirectional orientation
 - Impregnation quality
 - Fibre/matrix distribution
 - Low porosity



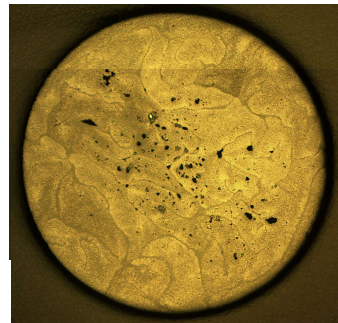
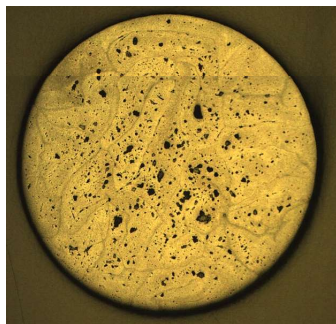
Pultrusion Conference 2021



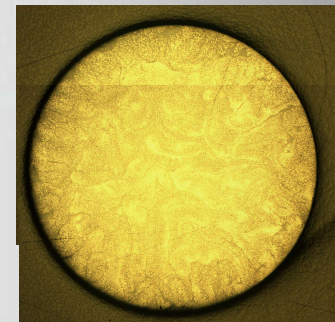
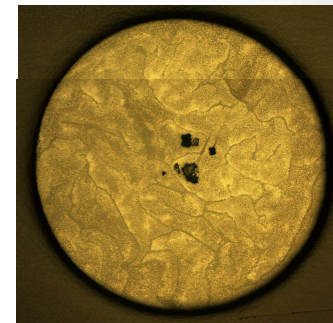
International Journal of Polymer Science 2014(6):1-8
M. S. Fedoseev, M. S. Grudzev, L.F. Derzhavinskaya

Challenges

- Dedicated pultrusion technology & machinery
 - Processing of high viscous thermoplastic
 - Intimate contact between fibre and polymer
 - Low porosity ($< \sim 1\%$)
 - Excellent fibre-matrix distribution
 - Good fibre orientation
 - Controlled surface quality



Pultrusion Conference 2021



Rod diameter: 4 mm

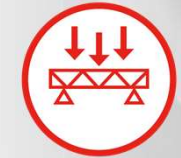


Applications



- Carbon / PEEK Rod

- High tensile modulus (~160 GPa) & strength (~2700 MPa)
- Heat resistant, Tg: 143°C
- Resistant to large number of aggressive fluids
- Good abrasion properties
- Bio compatible
- Radiolucent



STIFFNESS,
STRENGTH & IMPACT



HEAT, WATER
& CHEMICALS



ABRASION



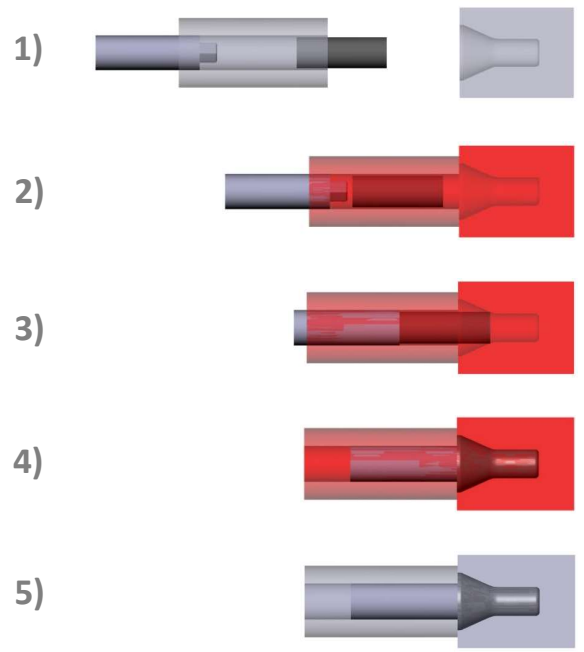
FUNCTIONAL

Applications

- Medical implants



Carbon / PEEK rod



Compression Flow Moulding (CFM) process

Pultrusion Conference 2021



courtesy of icotec AG



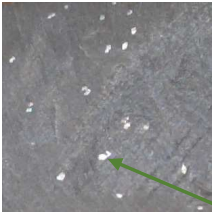
courtesy of icotec AG



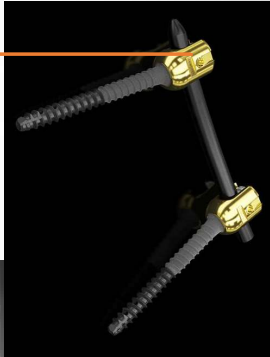
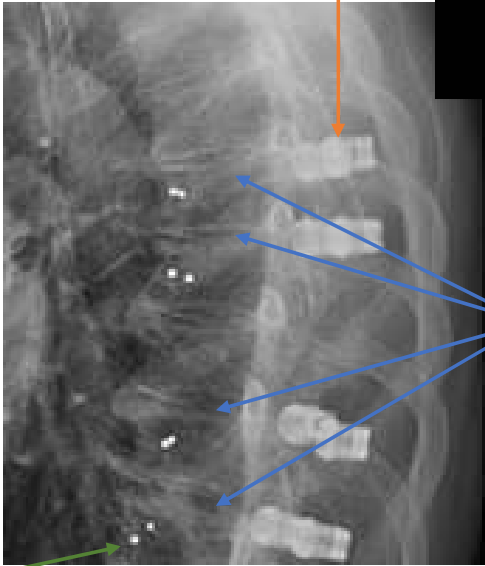
courtesy of icotec AG

Applications

- Functionalized Carbon / PEEK rod
 - Position of implants on X-rays pics



marker within radiolucent Carbon/PEEK materials

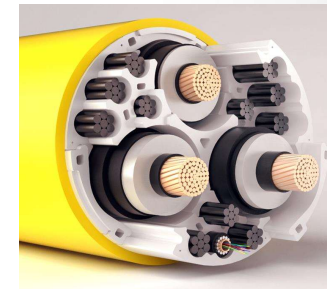


courtesy of icotec AG

**Carbon / PEEK
composite screws**

Applications

- New applications
 - Raw materials combination
 - Different fibres
 - Different polymers
 - Non composite materials

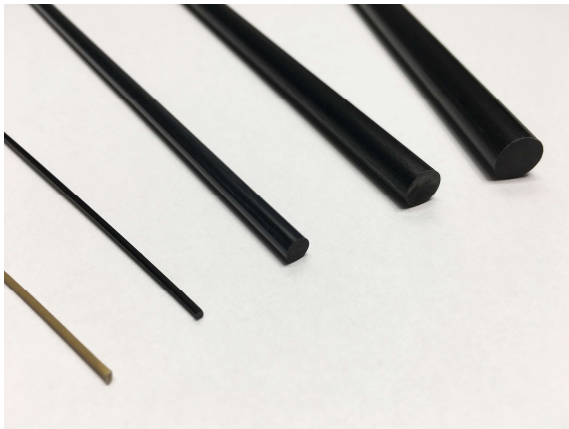


Source: Aker Solutions



Conclusion

- Pultrusion with continuous fibre and high-end thermoplastics
 - Challenges managed (elevated temperature, high viscosity, good impregnation)
 - Demanding applications such as medical implants
 - Material functionalization
- Continuous, monitored and automated manufacturing process



Dr. Anatole Gilliot

agilliot@suprem.ch

www.suprem.ch