

Materials Science (BMEGEMTAMM1)

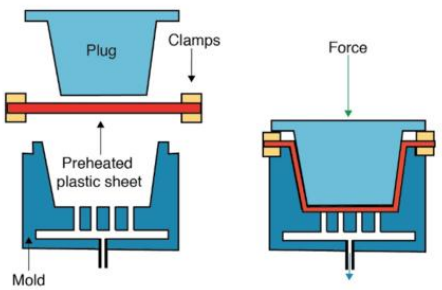
Lecturer: Dr. Ákos Pomázi
pomazi.akos@gpk.bme.hu

Negative thermoforming

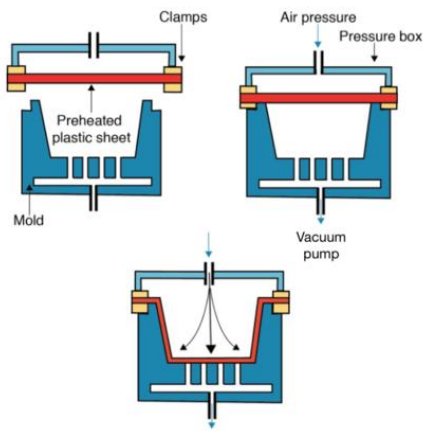
Positive thermoforming



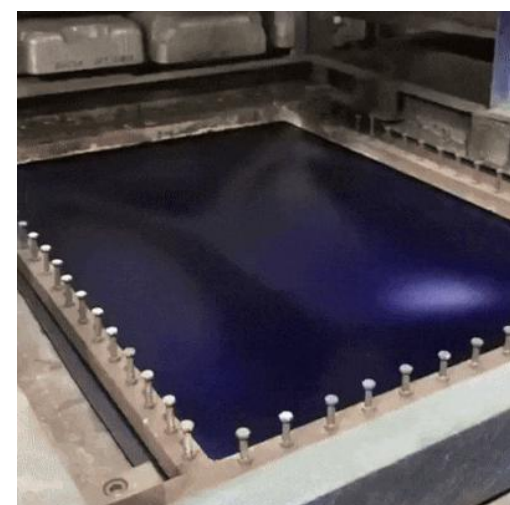
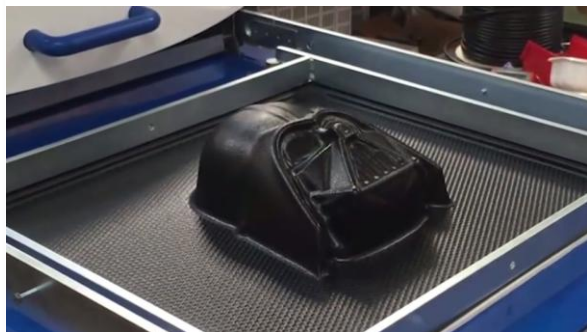
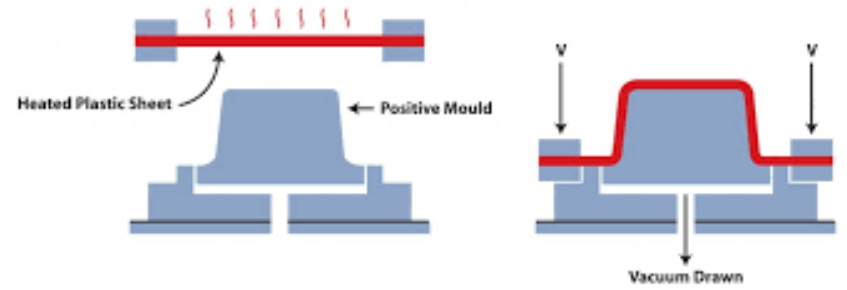
Mechanical Thermoforming



Pressure Thermoforming



Thermoforming Principle

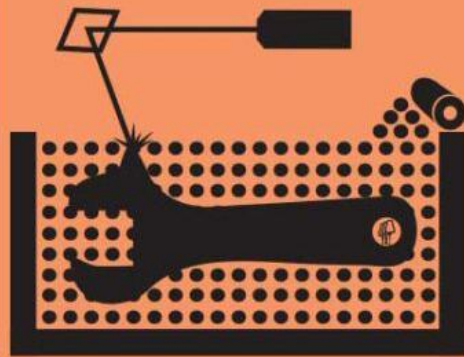


7 Families of Additive Manufacturing

According to ISO/ASTM52900-15 (formerly ASTM F2792)



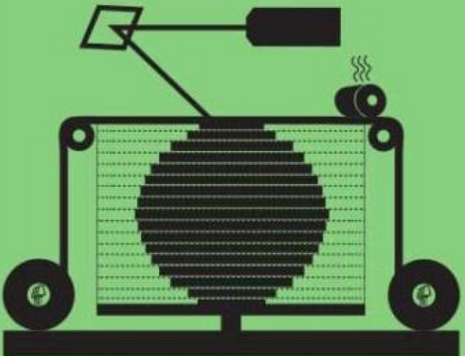
VAT PHOTO-POLYMERIZATION



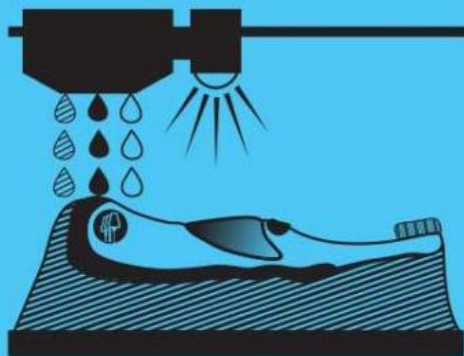
POWDER BED FUSION (PBF)



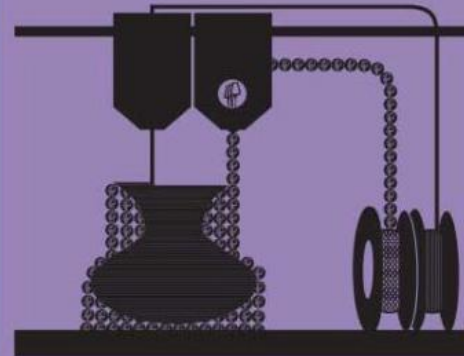
BINDER JETTING



SHEET LAMINATION



MATERIAL JETTING



MATERIAL EXTRUSION

Ian Gibson · David Rosen
Brent Stucker

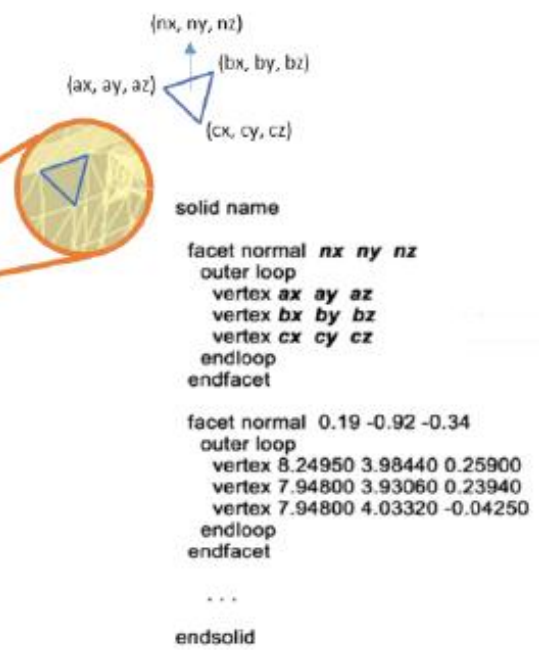
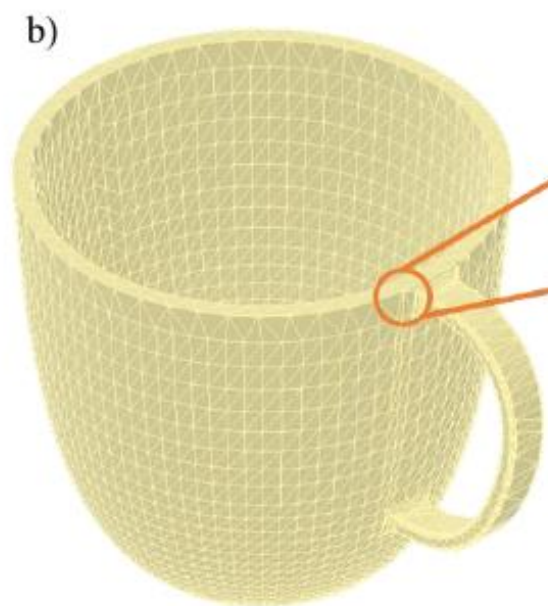
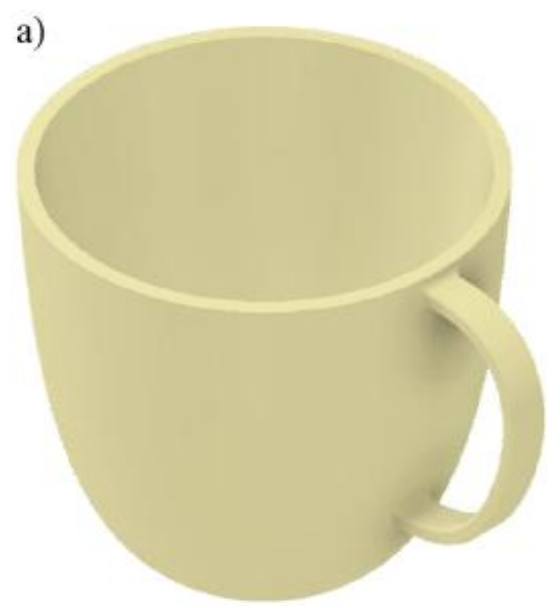
Additive Manufacturing Technologies

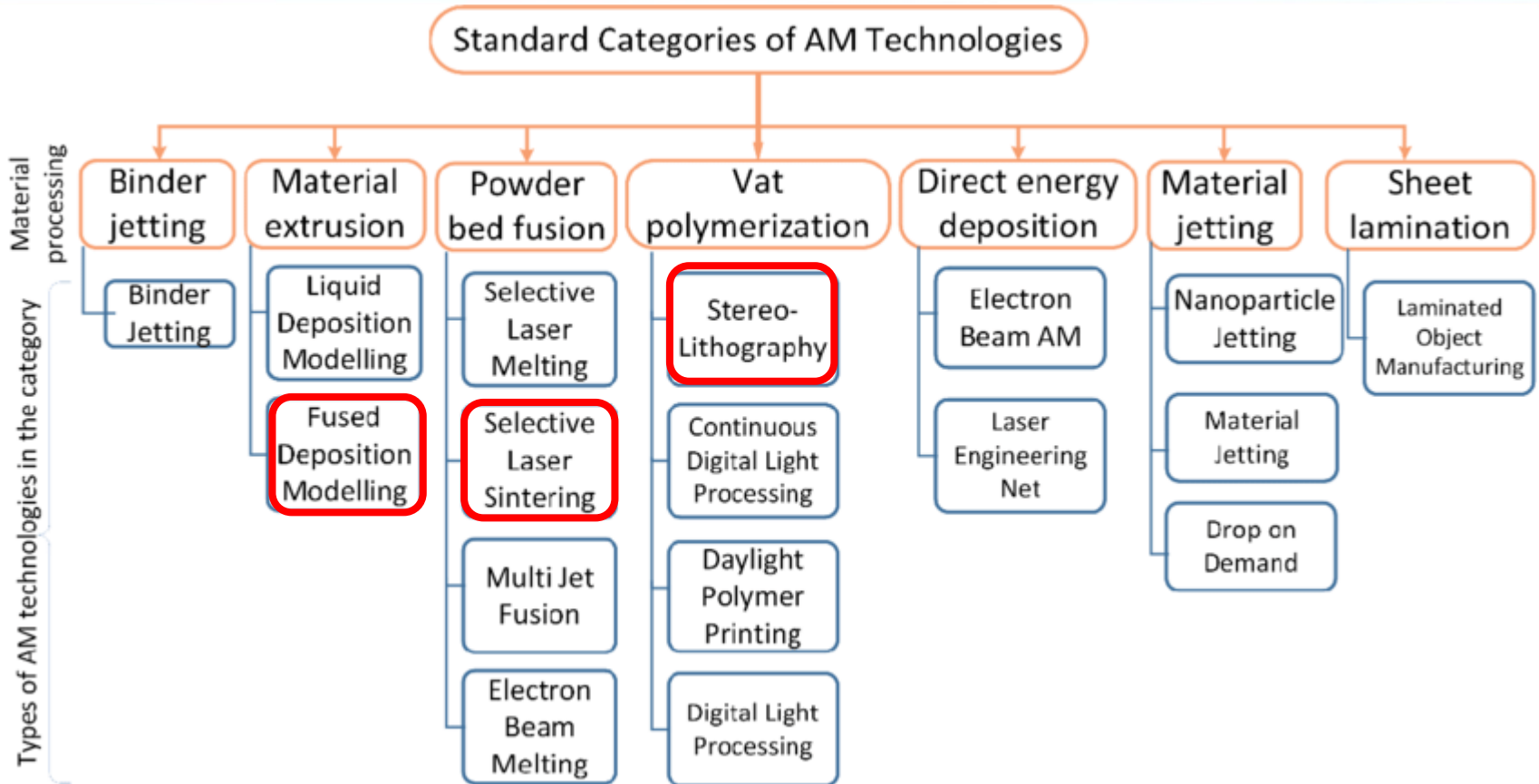
3D Printing, Rapid Prototyping, and Direct Digital Manufacturing

Second Edition

Springer

- STL:** Since additive manufacturing technologies build the product layer by layer, it is necessary to know the surface of our 3D model and then slice it into sections corresponding to the layer thickness. This is what the proprietary software of prototyping equipment is designed for, and its standard input format is STL (Standard Tessellation Language). Since the STL file is the result of an approximation method, it will never be able to reproduce the 3D model 100%, except in cases bounded by flat surfaces (e.g., cubes, prisms, etc.). Translated with DeepL.com (free version)





- **Building the material layer by layer**
- **FDM – Fused Deposition Modelling (raw material: polymer filament; melting)**
- **SLA – Stereo-lithography (PolyJet® technology; raw material: photopolymer)**
- **SLS – Selective Laser Sintering (raw material: polymer powder)**



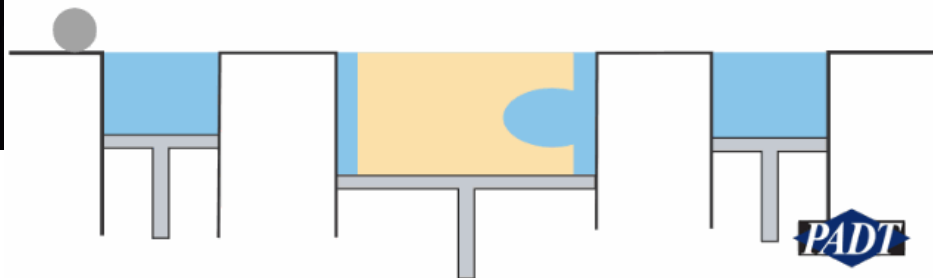


3D printing



Details look great at .1mm layer height

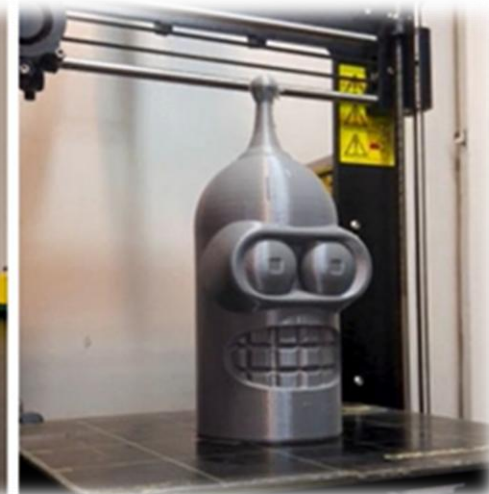
Selective Laser Sintering (SLS)



www.PADTINC.com

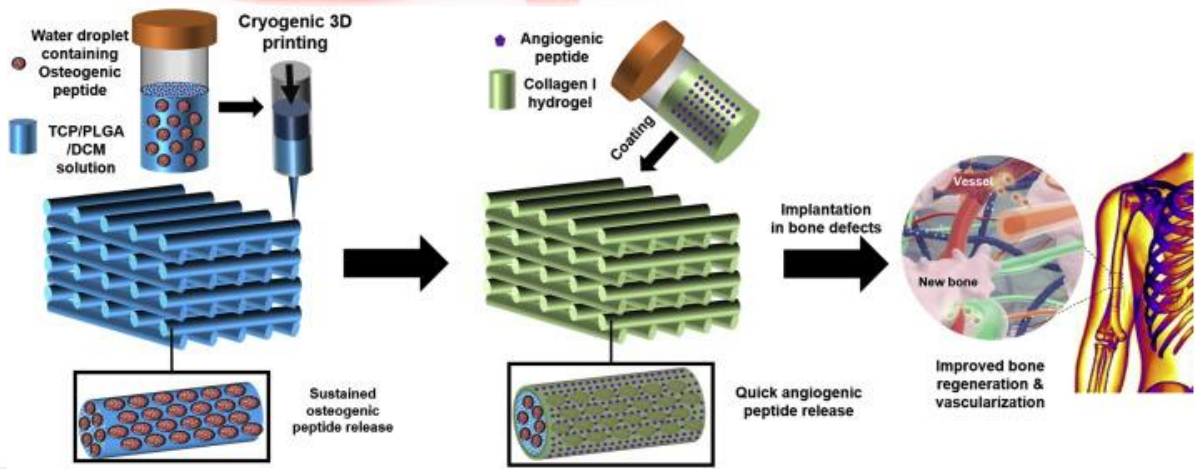


GIFSOUP.COM



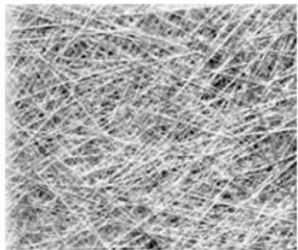


3D printed products



Composite:

- a **multiphase** (composed of components separated by phase boundaries)
- **complex** (multicomponent) structural material
- consisting of a **reinforcing material** (typically fiber reinforcement)
- and a **matrix**, and is characterized by
- **an excellent bond (adhesion, bonding)** between the high-strength and typically high-modulus-of-elasticity (fibrous) reinforcing material and the typically lower-strength but tough (high-impact-resistant) matrix,
- which **remains durable** even under high levels of deformation and stress.



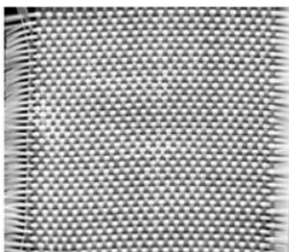
(a)



(b)



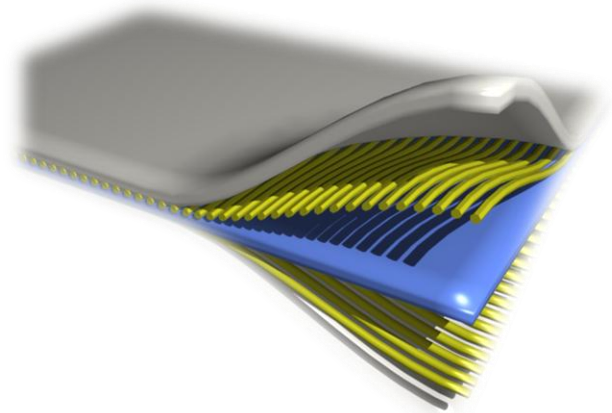
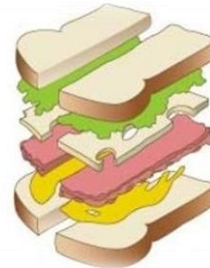
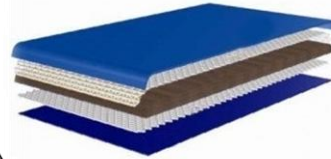
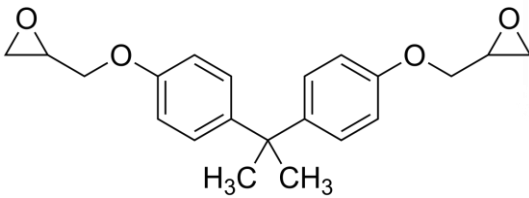
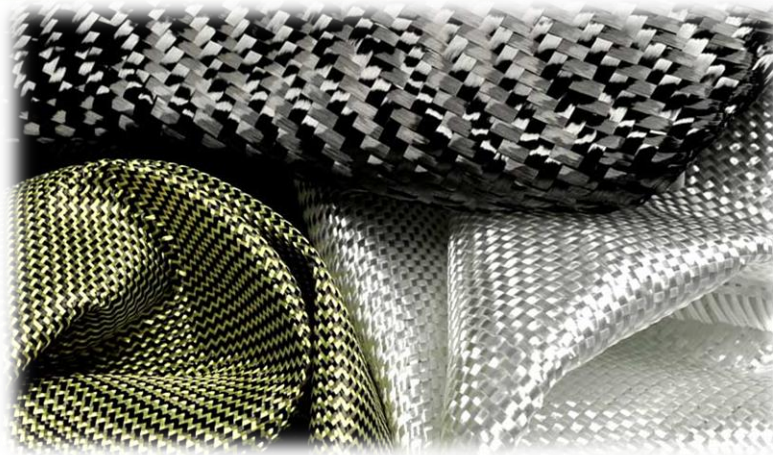
(c)



(d)



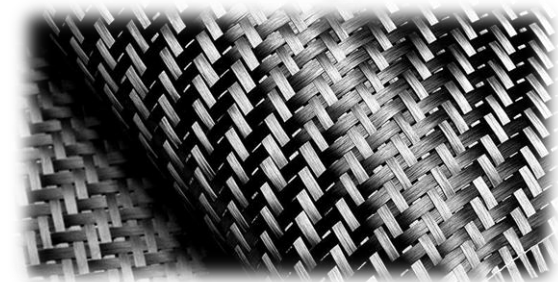
- **Matrix:**
 - Epoxy
 - Unsaturated polyester
 - Vinylester etc.
- **Fibre reinforcement:**
 - Glass
 - Carbon
 - Polyethylene
 - Polyamide (aramid, Kevlar®) etc.



FIBER

MATRIX

COMPOSITE

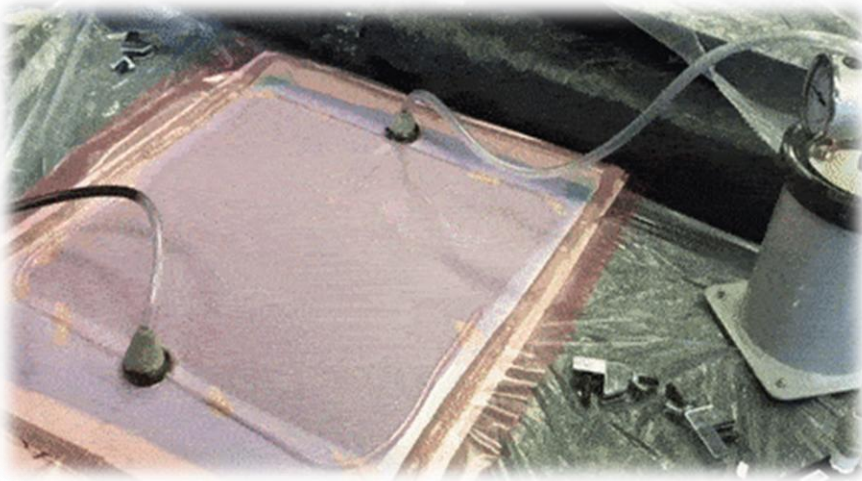




The surface of the model is coated with resin.



Hand lamination



Vacuum infusion

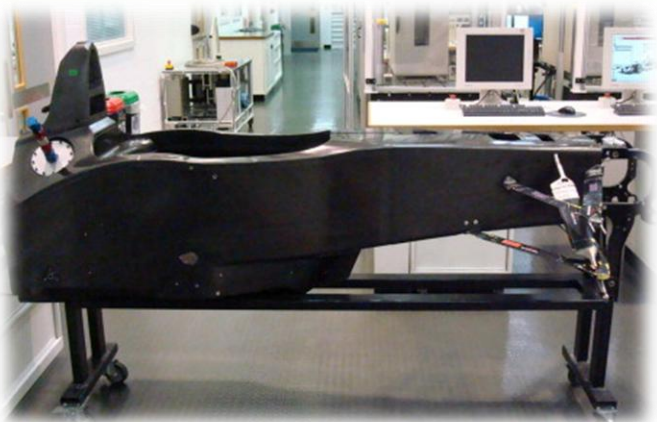


autoclave (from prepreg)



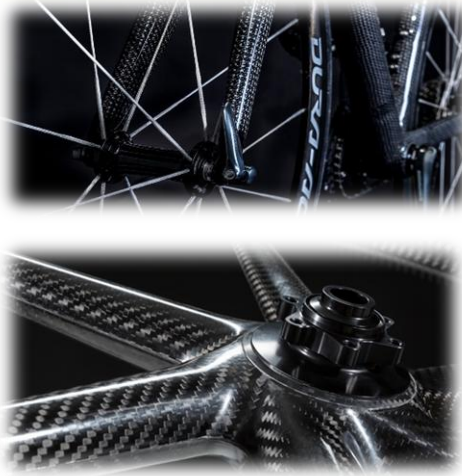


Composite products



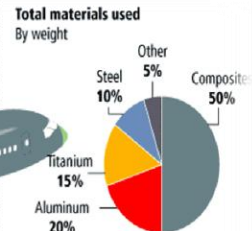
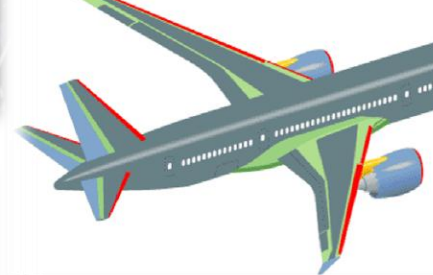


Composite products



Materials used in 787 body

- Fiberglass
- Aluminum
- Carbon laminate composite
- Carbon sandwich composite
- Aluminum/steel/titanium

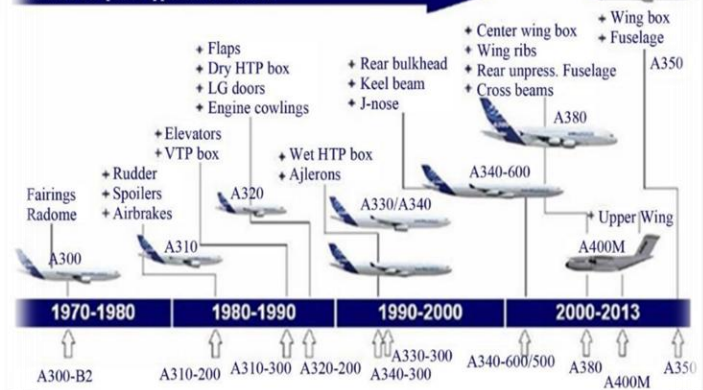


By comparison, the 777 uses 12 percent composites and 50 percent aluminum.

(a)



Evolution composite application at Airbus



(b)





Thank you for your attention!

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