Fiber Reinforced Plastic materials

“Designing a lighter future with Composites”

Fraunhofer IFAM
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This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation

Agenda

- Material
- Typical material properties
- Manufacturing processes
- Typical applications

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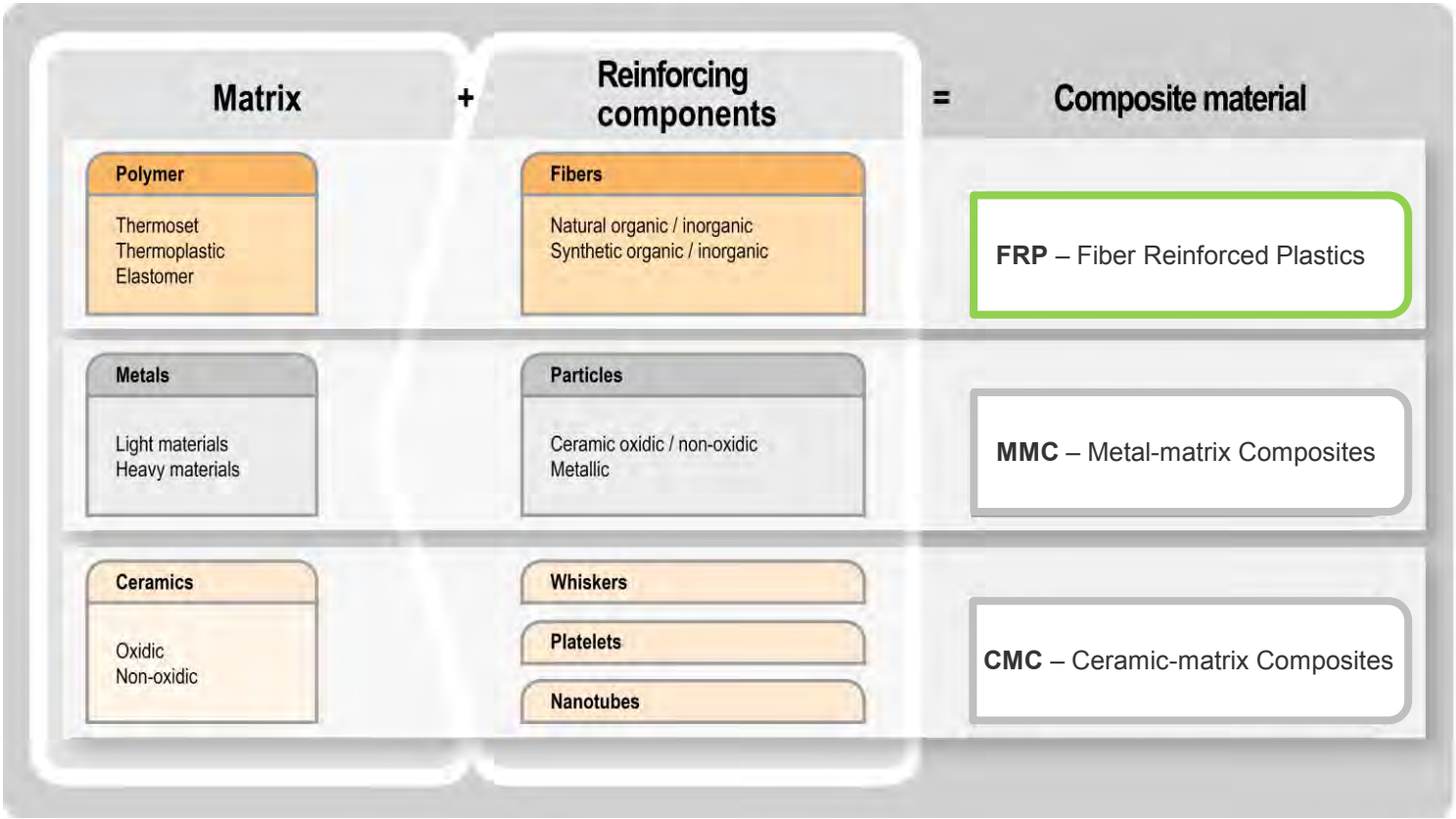
Material

Composite: minimum two components



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LightRight Materials for Lightweight Design

Material
Why FRP?

- Weight saving
- High strength and stiffness with simultaneously very low density
- Freedom of shape/design
- Good resistance to corrosion
- Low thermal conductivity
- High specific energy absorption
- Low coefficient of thermal expansion

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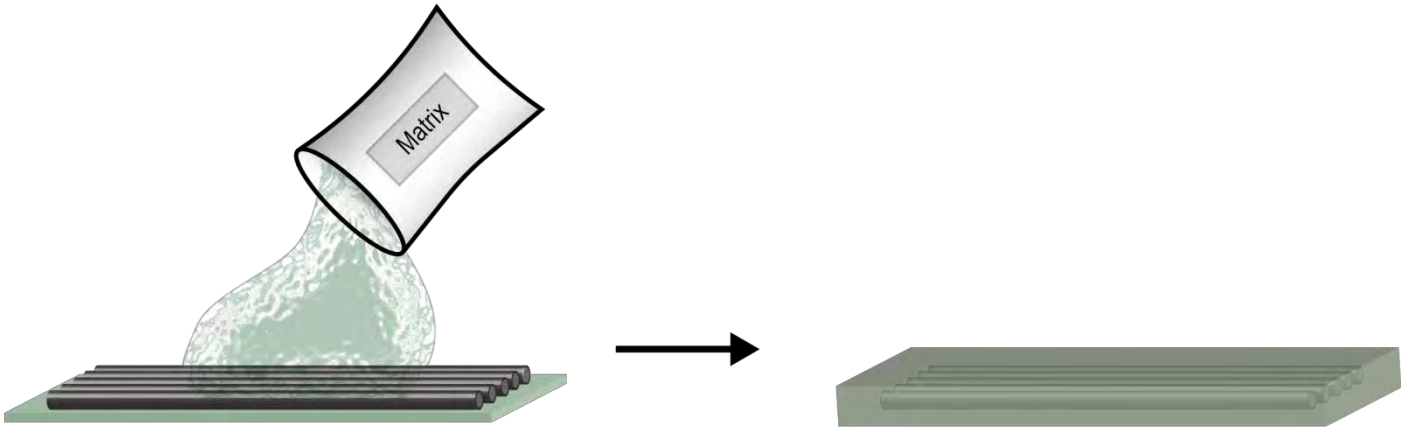
Material
Components

- FRPs consist of:
  - Reinforcing fibers
  - Plastic matrix



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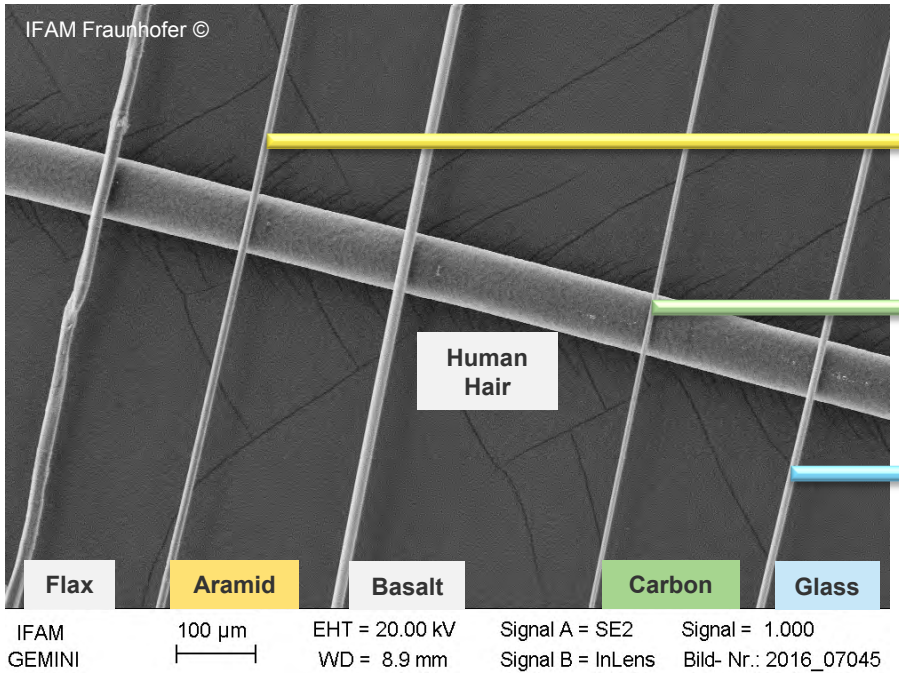
Material

Functions and properties of the components

- Fibers
  - Force absorption
  - Reinforcement



Water/moisture absorption

Negative coefficient of thermal expansion

Isotropic

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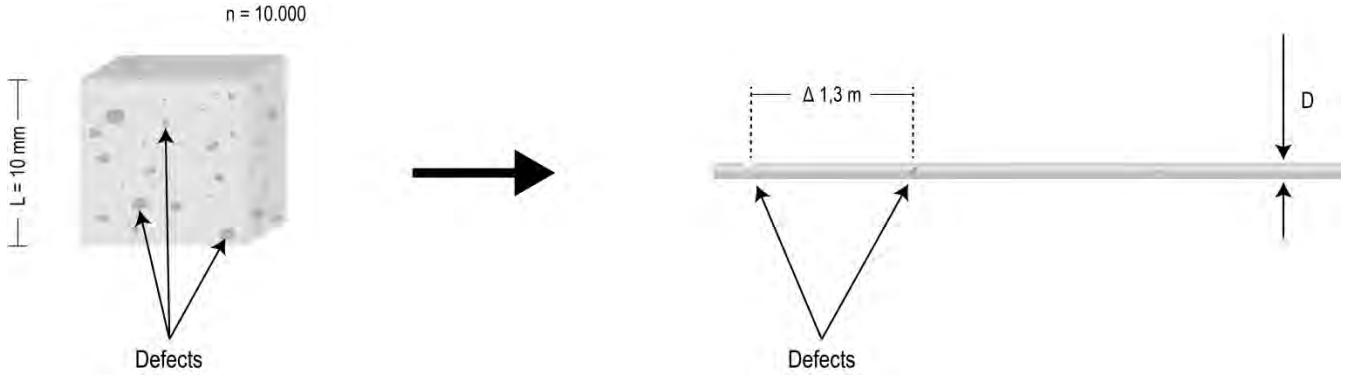
Material

Why fibers as reinforcement?

- Size effect
  - Defects weaken the material
  - When a fiber is drawn from the cube, the defects become smaller and the regions without defects become larger



  - The thinner the fibers, the higher their strength.

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Material

Functions and properties of the components

- Plastic matrix
  - Fiber positioning and support
  - Force transfer between fibers
  - Fiber protection

Unsaturated polyester:
HIGH SHRINKAGE

Epoxy resins:
LOW SHRINKAGE

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Material

Functions and properties of the components

- Fiber ✓
- Matrix ✓

Done?

Unsized

Compatibility

Protection

SIZING!!

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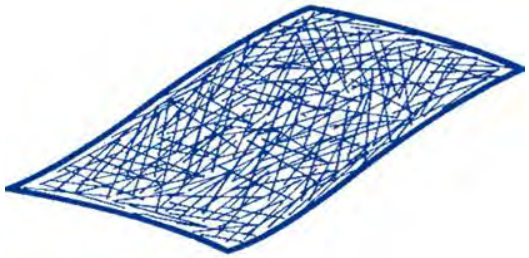
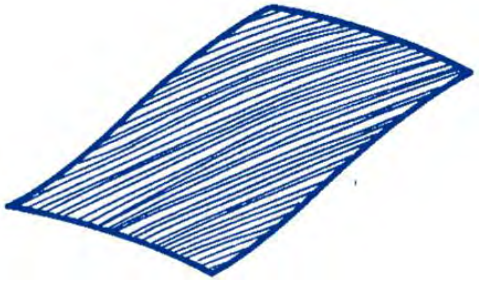
Material
Fiber architectures

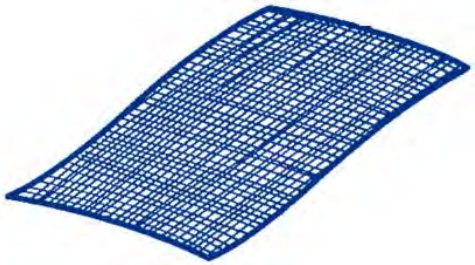
- Semi-finished products



Random mats of chopped fibers



Unidirectional (UD)



Textile fiber patterns (weaving, knitting, braiding, etc.)

Parameters

Different **drapability** and **deformation resistance**

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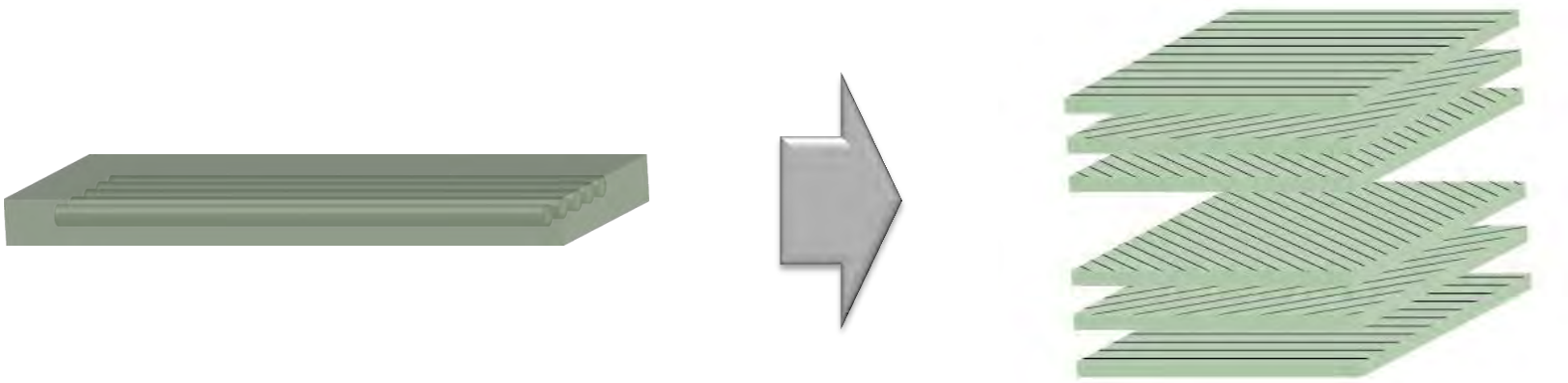
FRP properties
Mechanical properties

- From a single layer to a laminate
  - Symmetric
  - Orthotropic



Individual layer (lamina)

Stacking of multiple layers (laminate)

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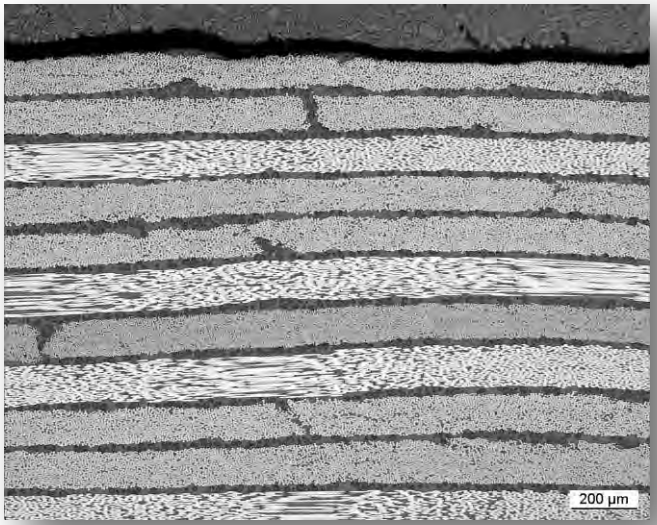
FRP properties
Mechanical properties

- Are FRPs homogenous?
  - microscopically not homogenous



FRP‘s cross-section

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FRP properties
Climatic influences

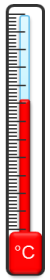
- Ageing

Moisture

UV light

Lightning

Temperature



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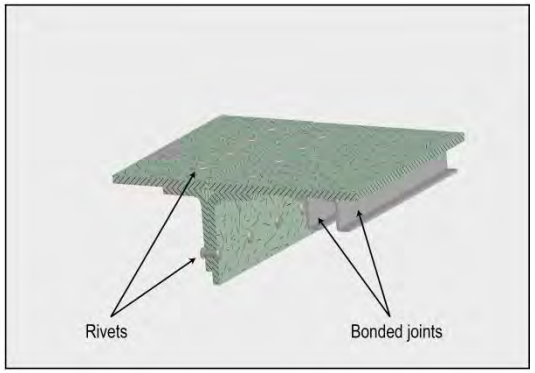
Design

Philosophy: weight, recycling, manufacturing process…

- Construction methods

Integral	Differential	Integrating
		
One material	Multi-material As much as possible	Multi-material As many as necessary but as few as possible

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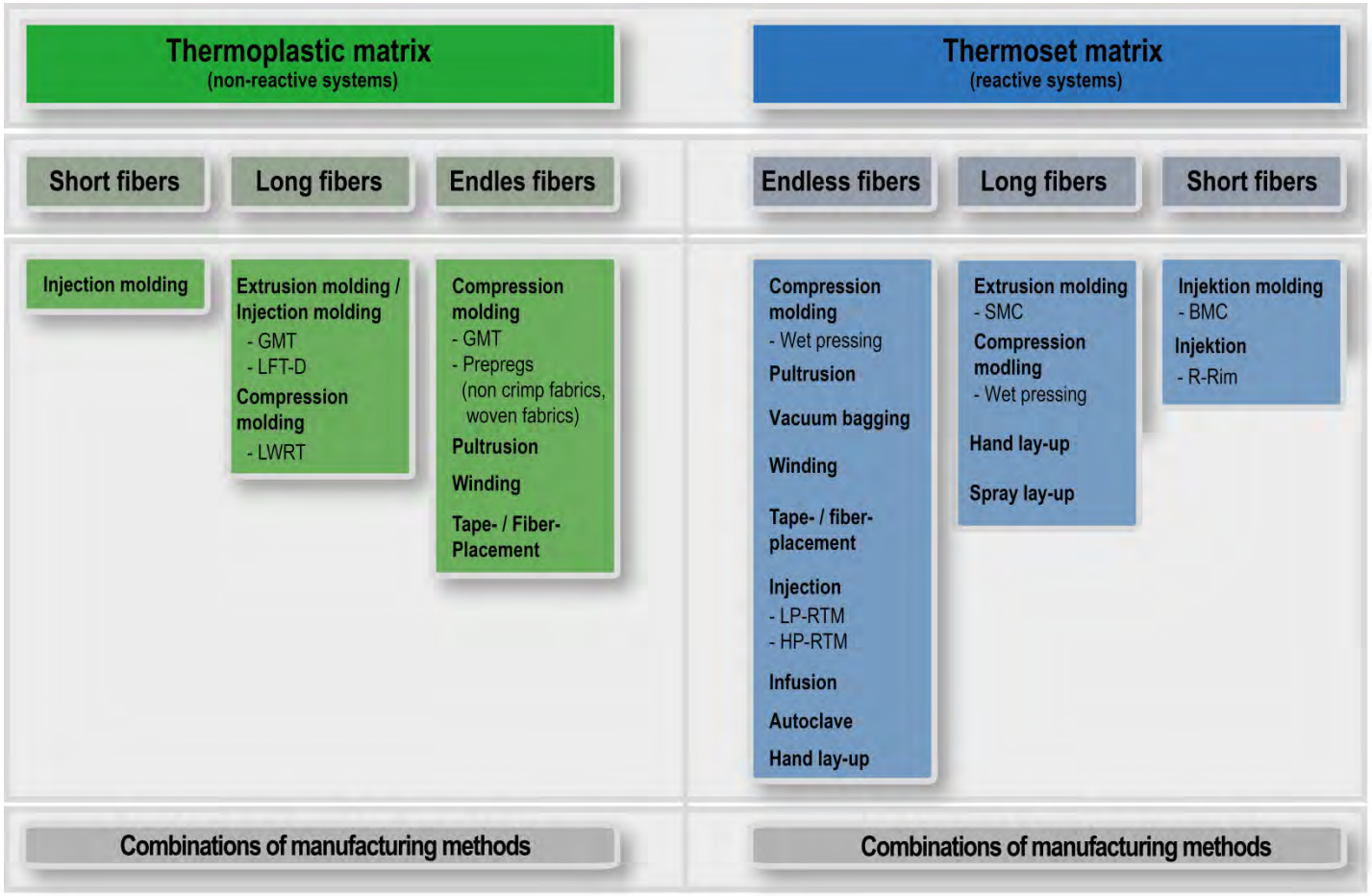
Manufacturing methods

According to matrix and fiber types



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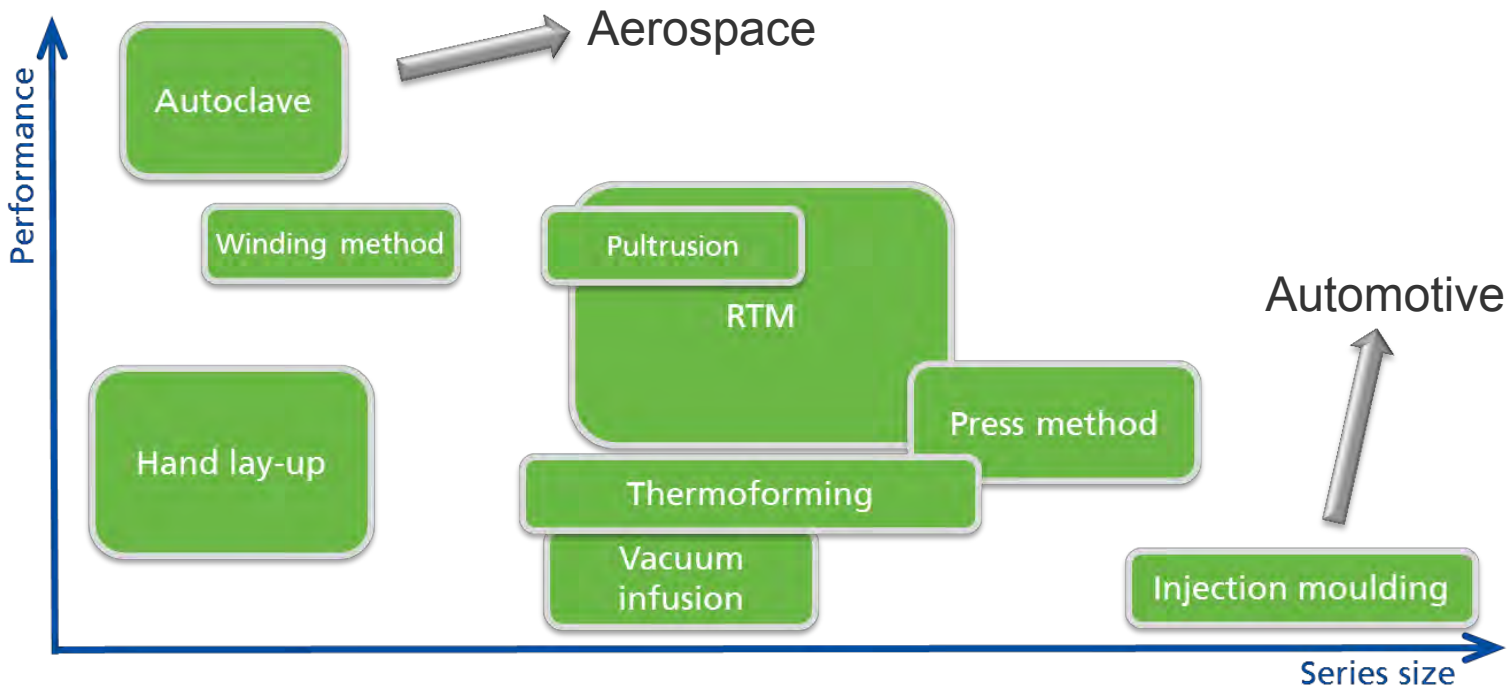
Manufacturing methods

Performance vs. Series size

- Manufacturing performance



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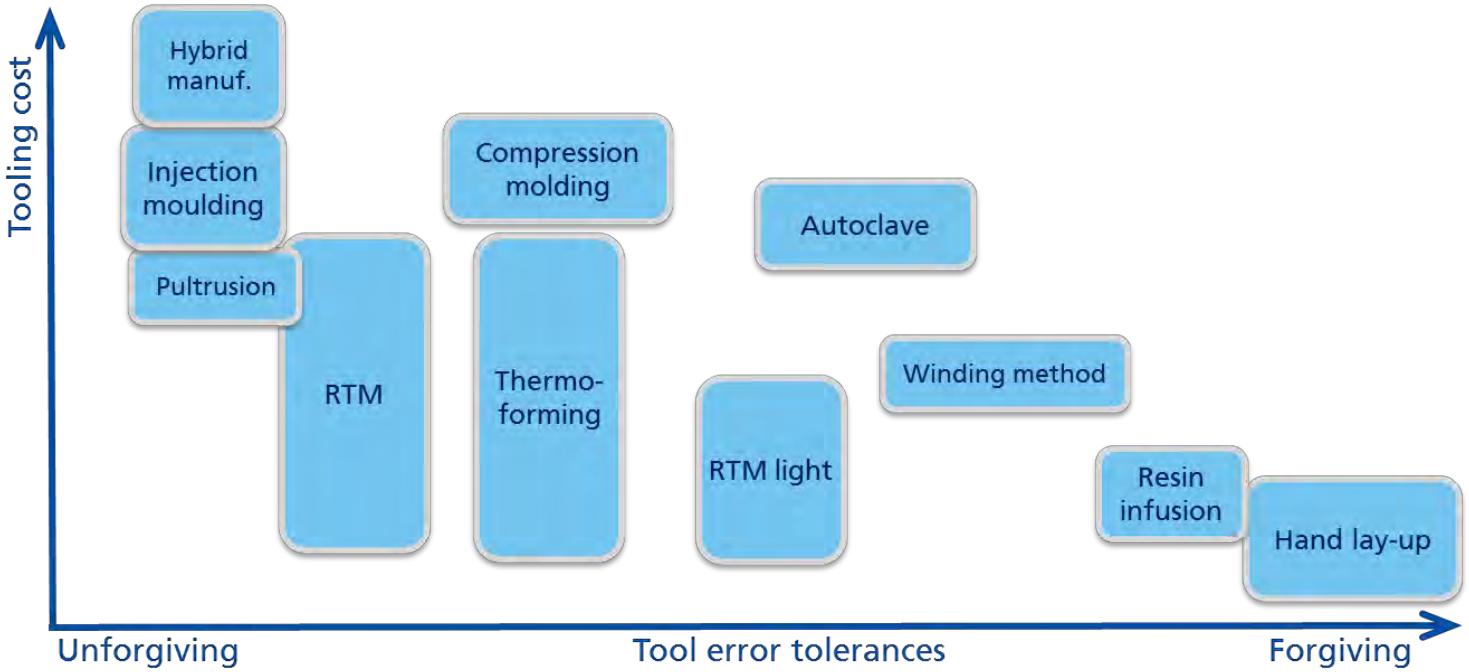
Manufacturing methods

Error tolerances vs. Tooling costs

- Manufacturing tooling costs and tool tolerances



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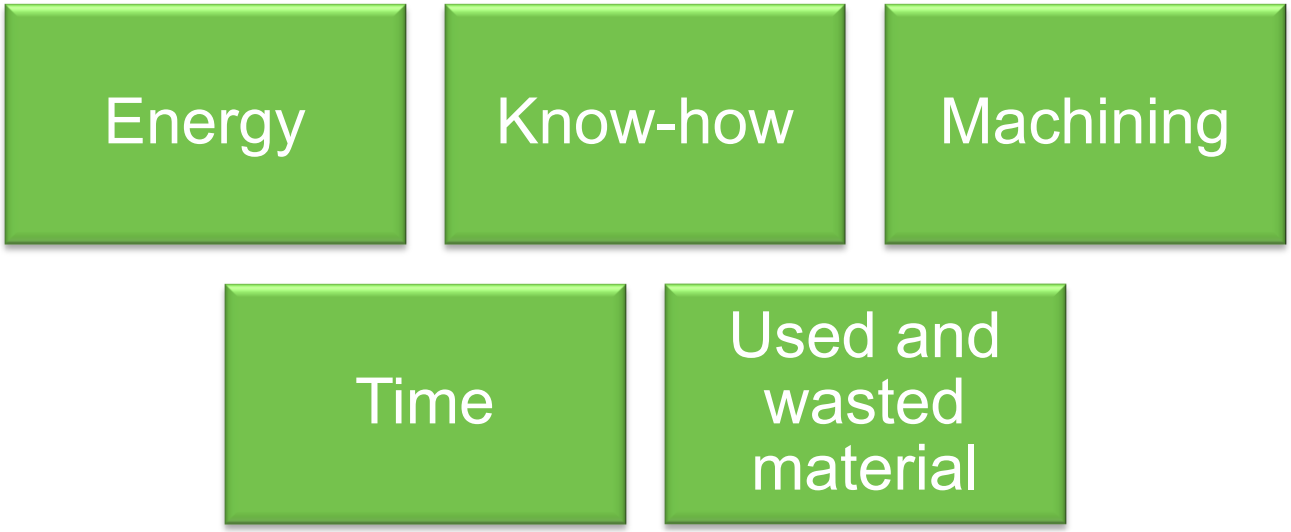
Manufacturing methods

Costs

- Only tooling costs?...



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Manufacturing methods
Selection

- To keep in mind:
  - Fiber type
  - Fiber length
  - Matrix type
  - Pot life
  - Cycle time
  - Performance
  - Fiber volume content
  - All costs!

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THANK YOU

FOR YOUR ATTENTION!

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