



Prepeg Information

# Prepeg Technology at Polymer Engineering

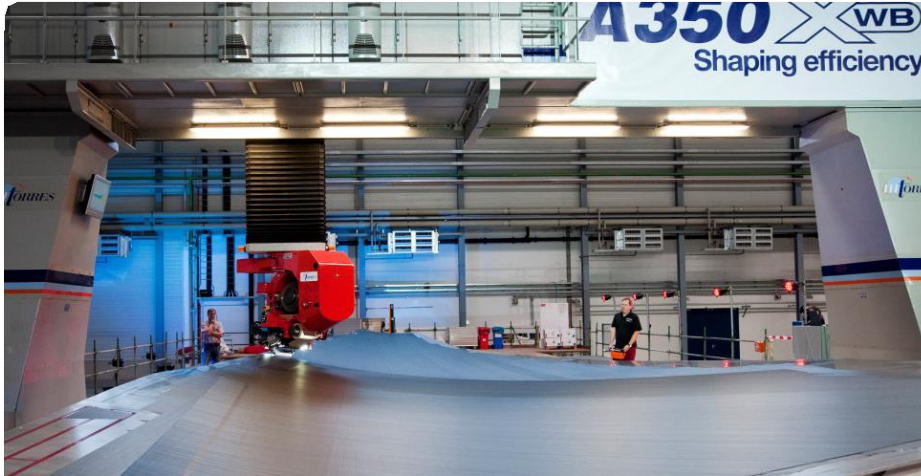
Development of modern prepeg materials

# Applications of Prepreg Materials - Overview





## Aerospace - Structural Components

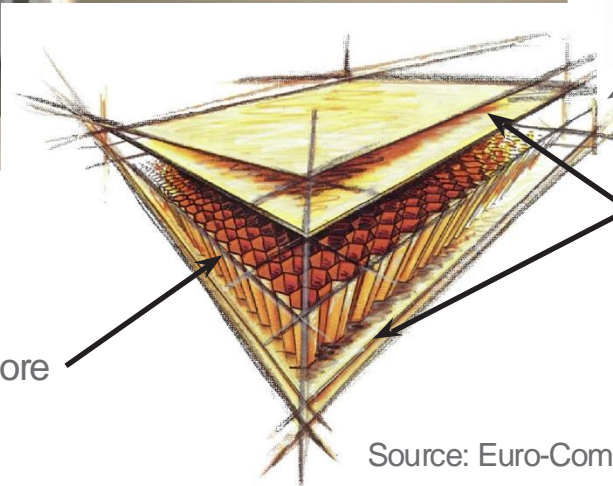
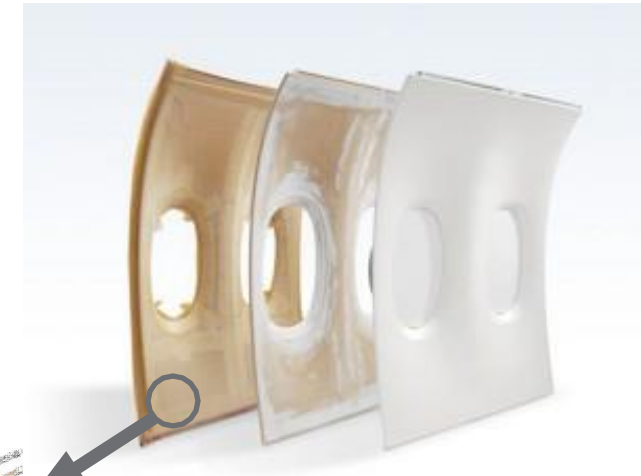


# Aircraft Interiors



A350 cabin; Source: Airbus

Source: Diehl Aircabin



Honeycomb core

Prepreg face sheets

Source: Euro-Composites

## Automotive: Press moulding for high volume production



Single-line-injection    Dry fibre placement  
conventional  
**prepreg** processes  
< 5.000

TP-one-shot-processes

TP-RTM    RTM    PU-RTM

Pullbraiding    Pultrusion    ...

1.000 - 50.000

Press moulding  
(SMC / GMT / **fast-prepreg**)

Combined injection  
and pressing processes

Plastic-metal-hybrids

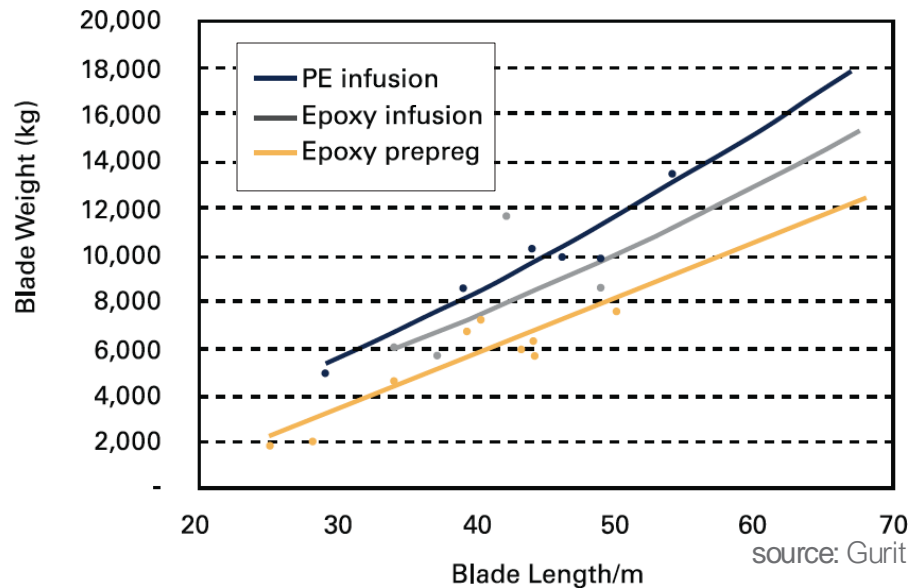
Injection and  
compression moulding  
...

50.000 - 300.000





## Wind Energy



### Goals:

- Reduction of process costs by automation
- Improved part quality:
  - Reduction of voids
  - Equal resin distribution
- Constant part quality

### New Challenges:

- Tack suitable for automated processing
- Shelf life of resin system (one component)



## Medical

### Carbon fibre preregs provide...

- ... low weight.
- ... high drapability to form individualized parts.
- ... high strength.
- ... X-ray transparency.



# Prepreg Processing Chain at Polymer Engineering

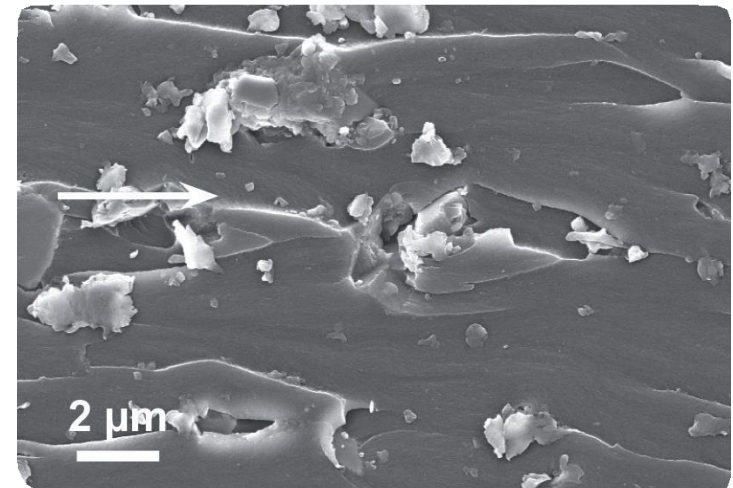




# Resin Development for Prepreg Processes

### Challenges for novel prepreg resin systems

- Optimize **tack properties** for automated placement
- **Fast curing** at moderate temperatures
- **Out of autoclave** curing
- Optimisation of cure induced **warpage and shrinkage**
- Functionalities:
  - **Fire behaviour**
  - **Electrical properties**
  - **Barrier properties**
- Improved **Toughness**



## Equipment for Resin Formulation

### Chemistry lab for formulation of **thermoset resins**

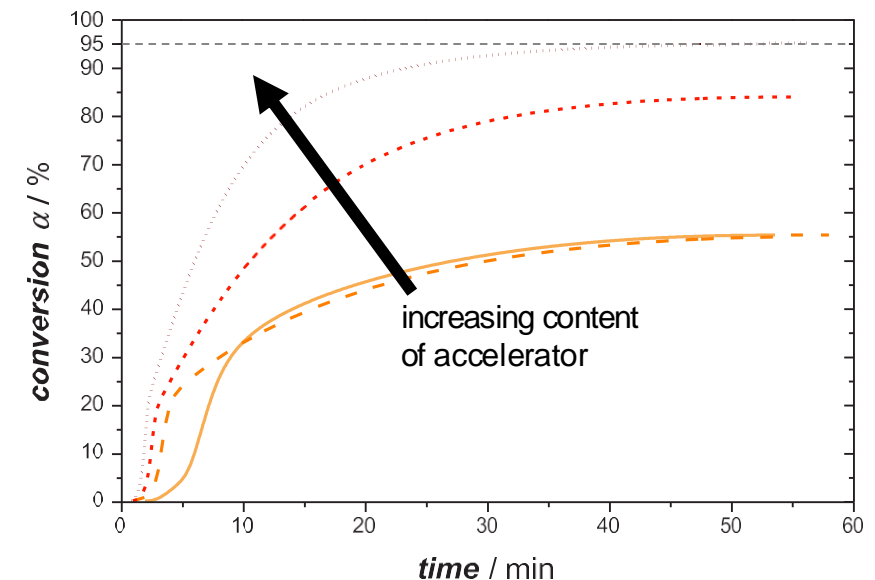
- Speed Mixer
- Curing Ovens
- Vacuum Mixing Unit

### Dispersion of **fillers** in nano- and micro scale

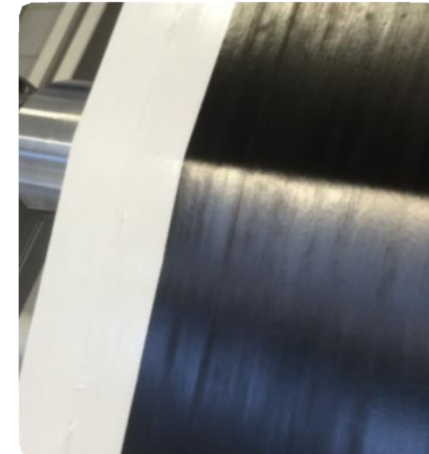
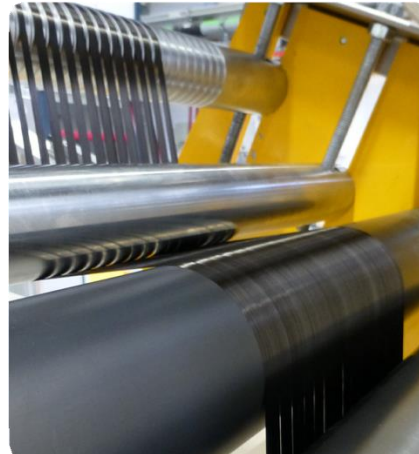
- Three-Roll-Mill
- Ultrasound Dispersing
- Dissolver stirrer

### Determination of **curing kinetics** and decomposition behaviour

- (High pressure) DSC
- Thermogravimetric Analyzer
- Rheology Lab



## Pilot Prepreg Plant

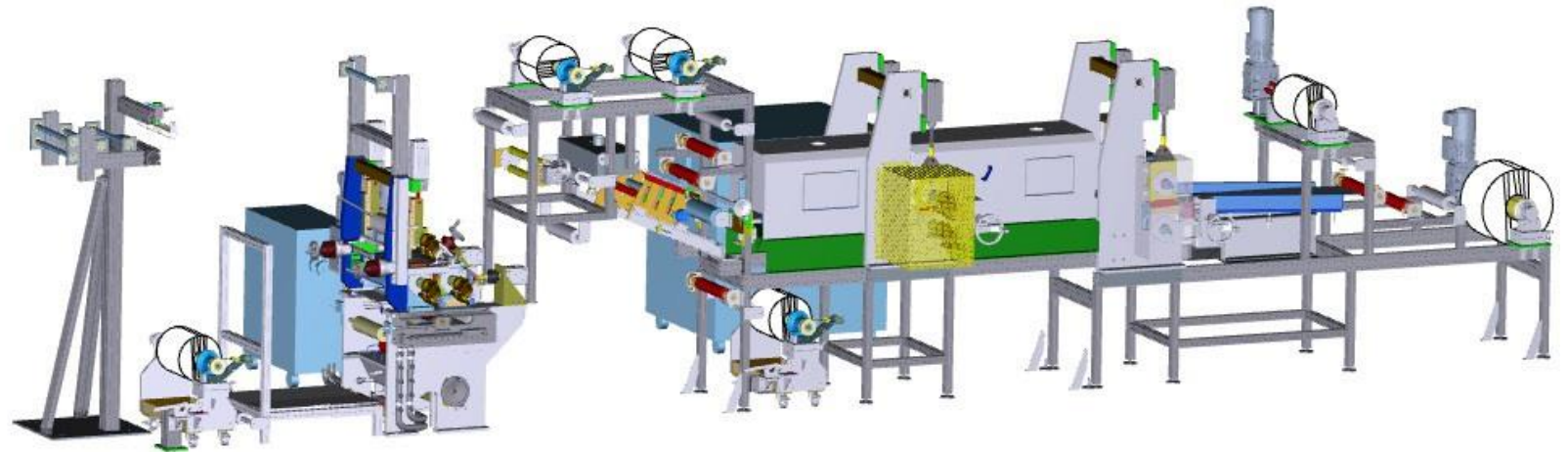
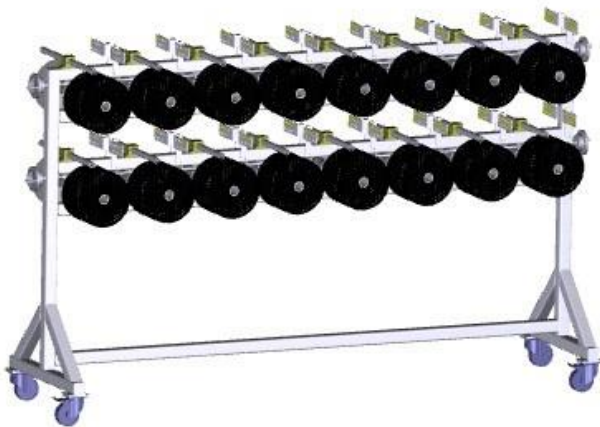




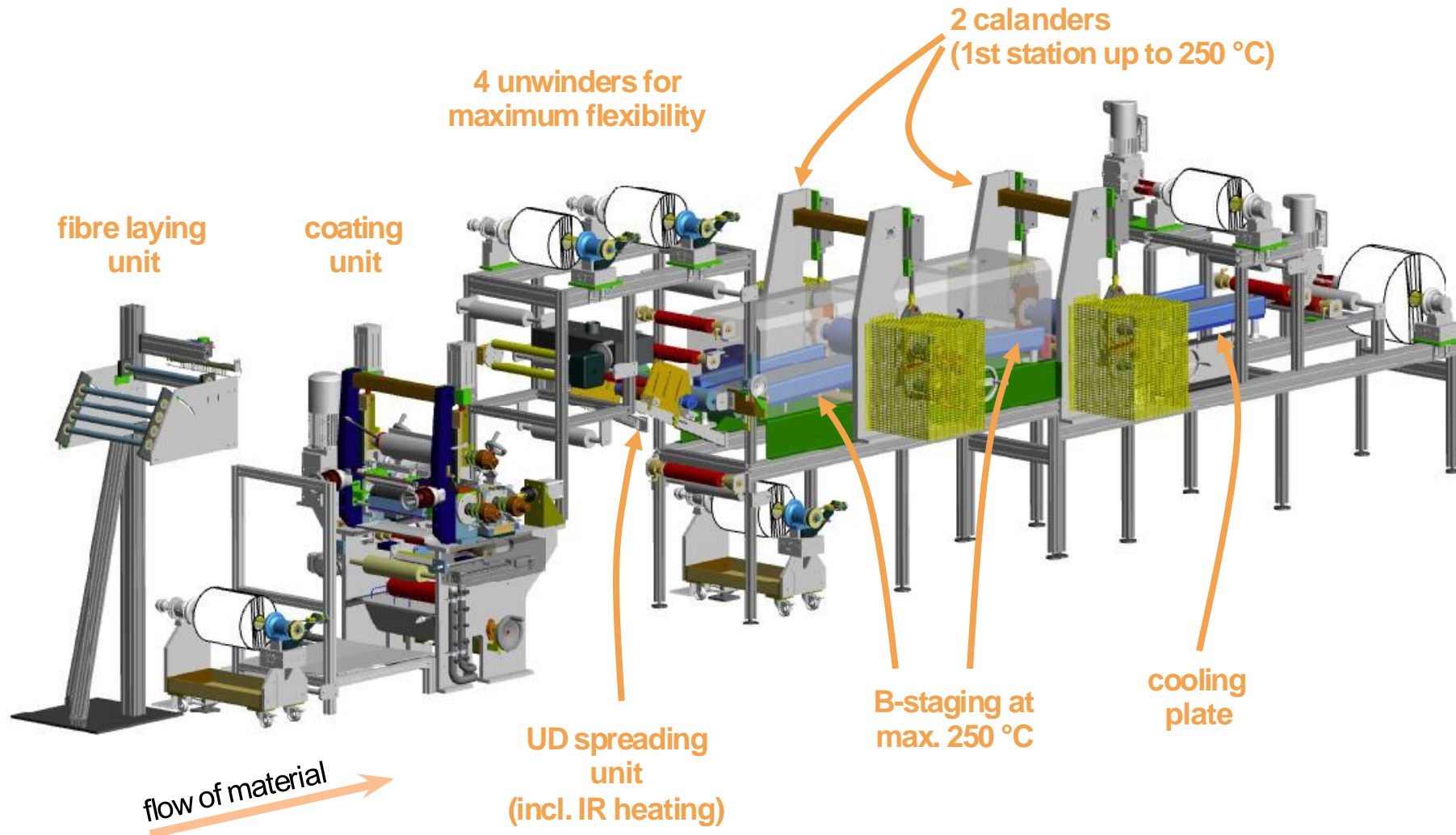
## Pilot Prepreg Plant

### Specification:

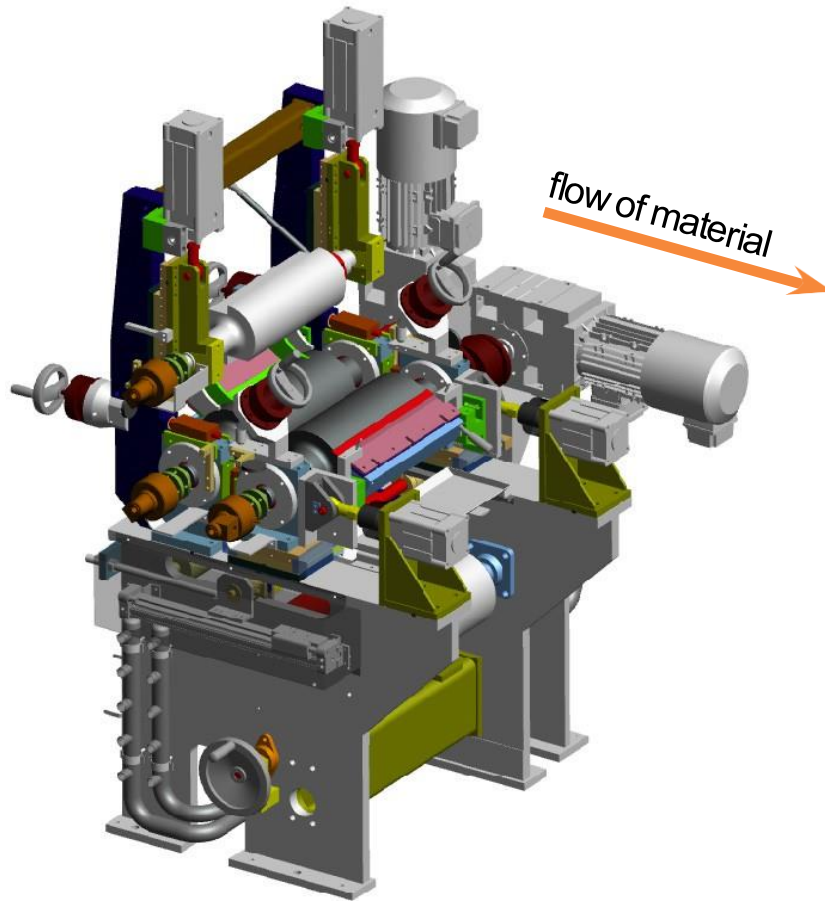
- Working width: max. 30 cm
- Reinforcements: up to 32 UD-Rovings or textile fabric
- Matrix systems: solvent free resin systems (hot-melt processing)
- Line speed: 1 to 10 m/min
- Dimensions: 16.5 m x 2 m x 2.5 m (l x w x h)



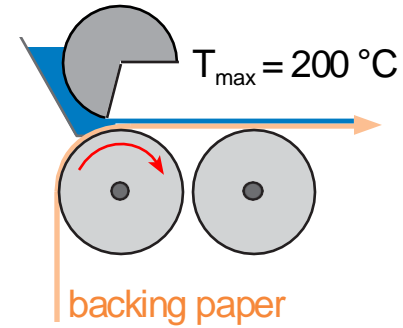
# Pilot Prepreg Plant - Technical Details



## Flexible coating unit

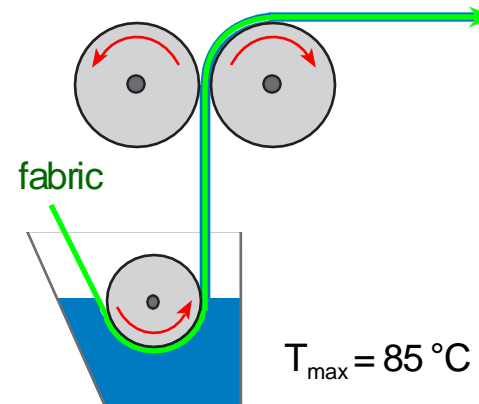


**comma bar**

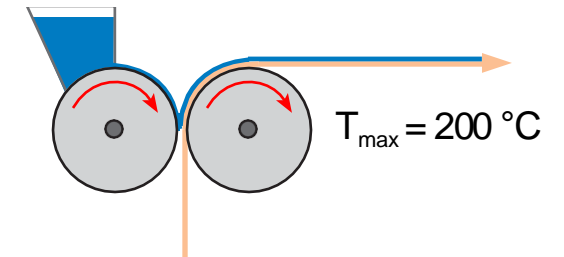


→ Preferred solution

**foulard**

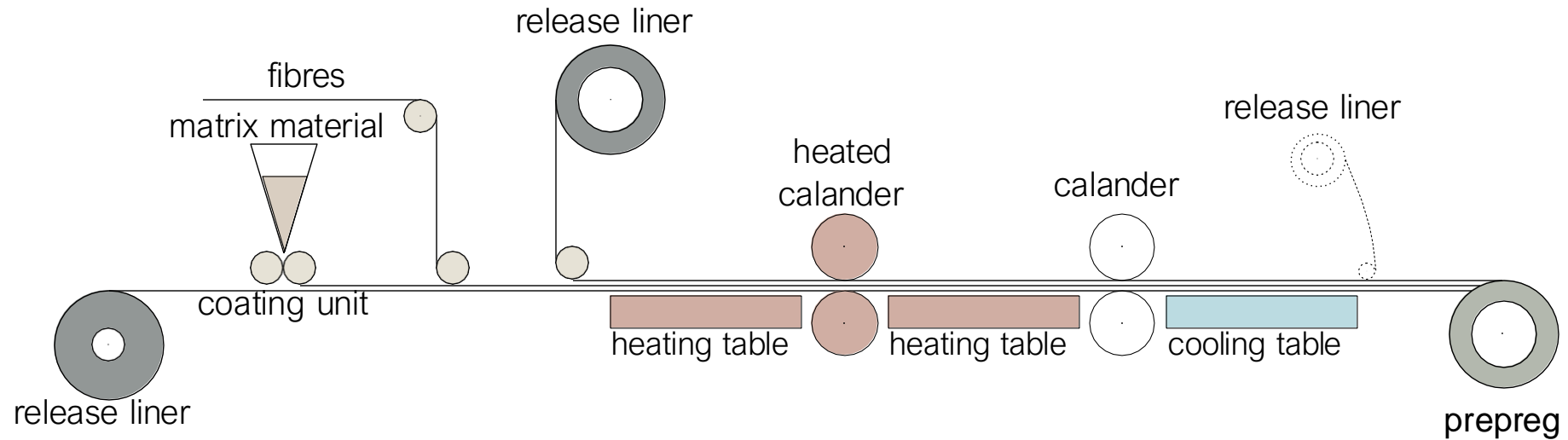


**indirect coating**





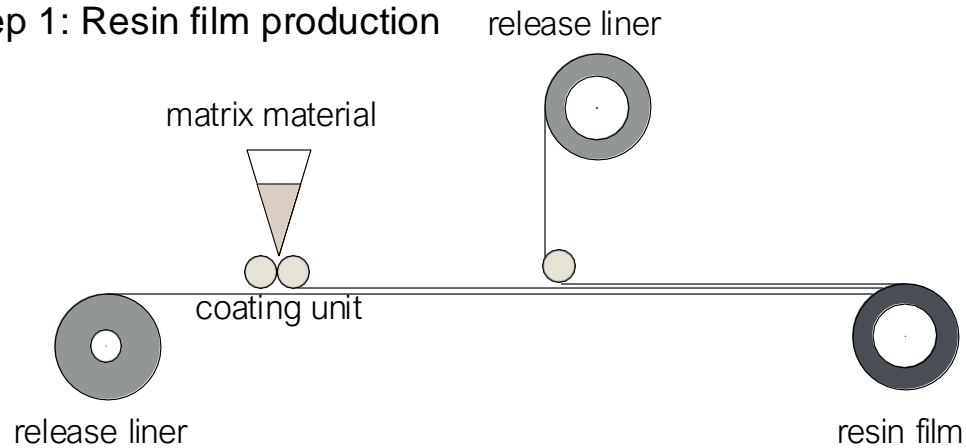
# Prepreg Processing - In-line Impregnation



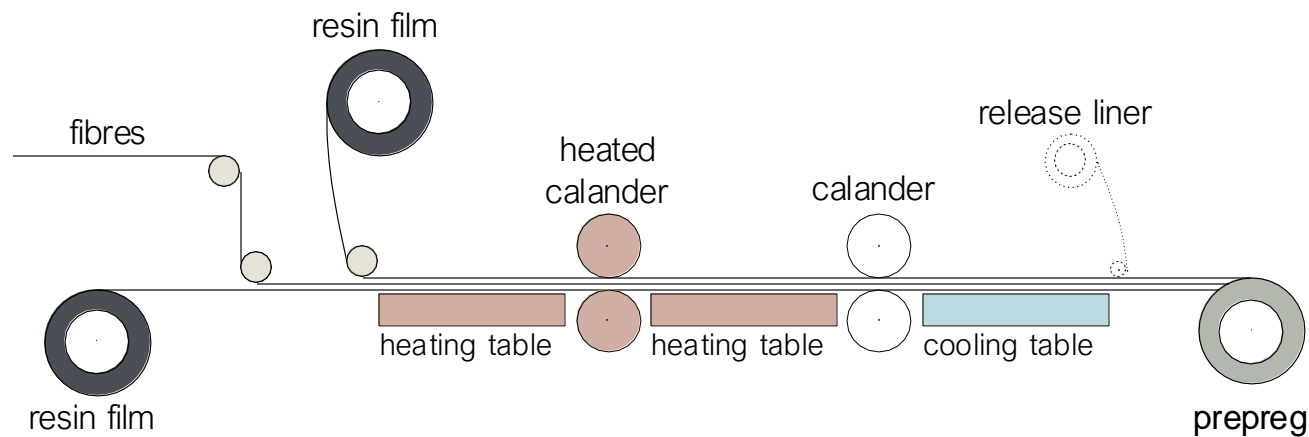
Direct in-line impregnation of UD-fibres or low aerial weight woven fabrics.

## Prepreg Processing - Off-line Impregnation

### Step 1: Resin film production



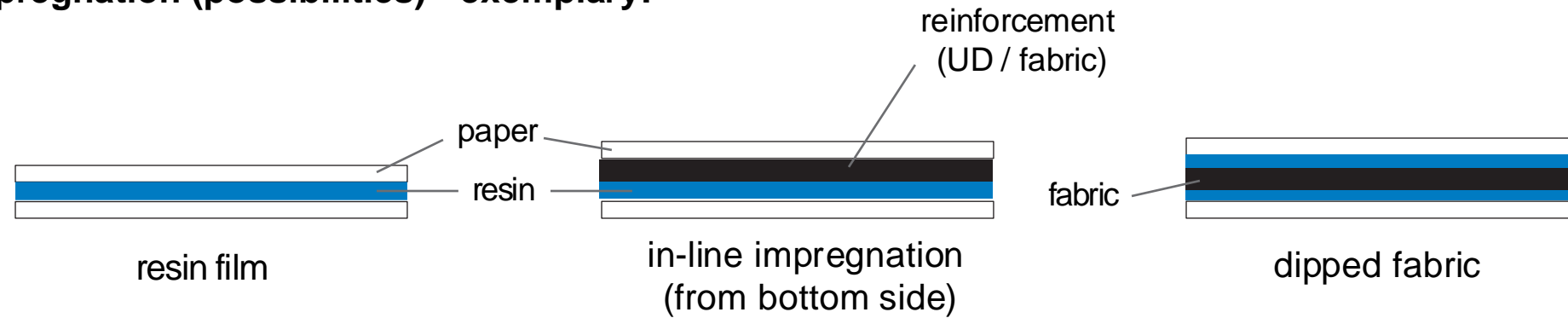
### Step 2: Prepreg impregnation



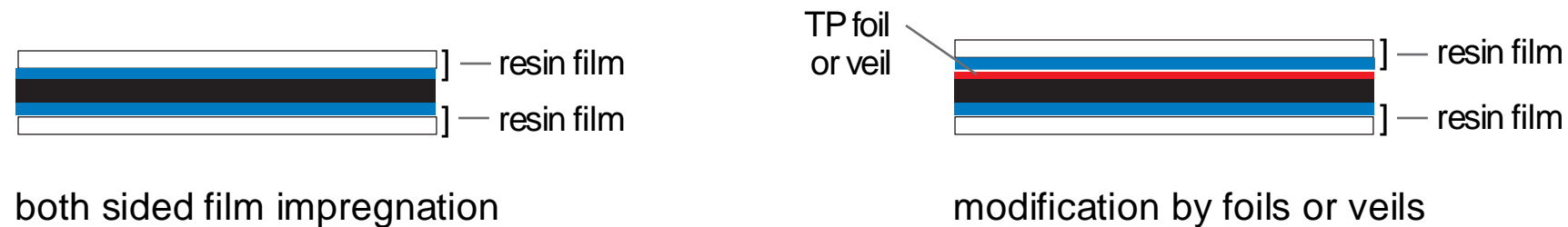
Bildquelle: 3M

# Maximum flexibility - tailoring prepregs

## In-line impregnation (possibilities) - exemplary:



## Off-line impregnation (possibilities) - exemplary:





# Characterization of Prepreg Properties

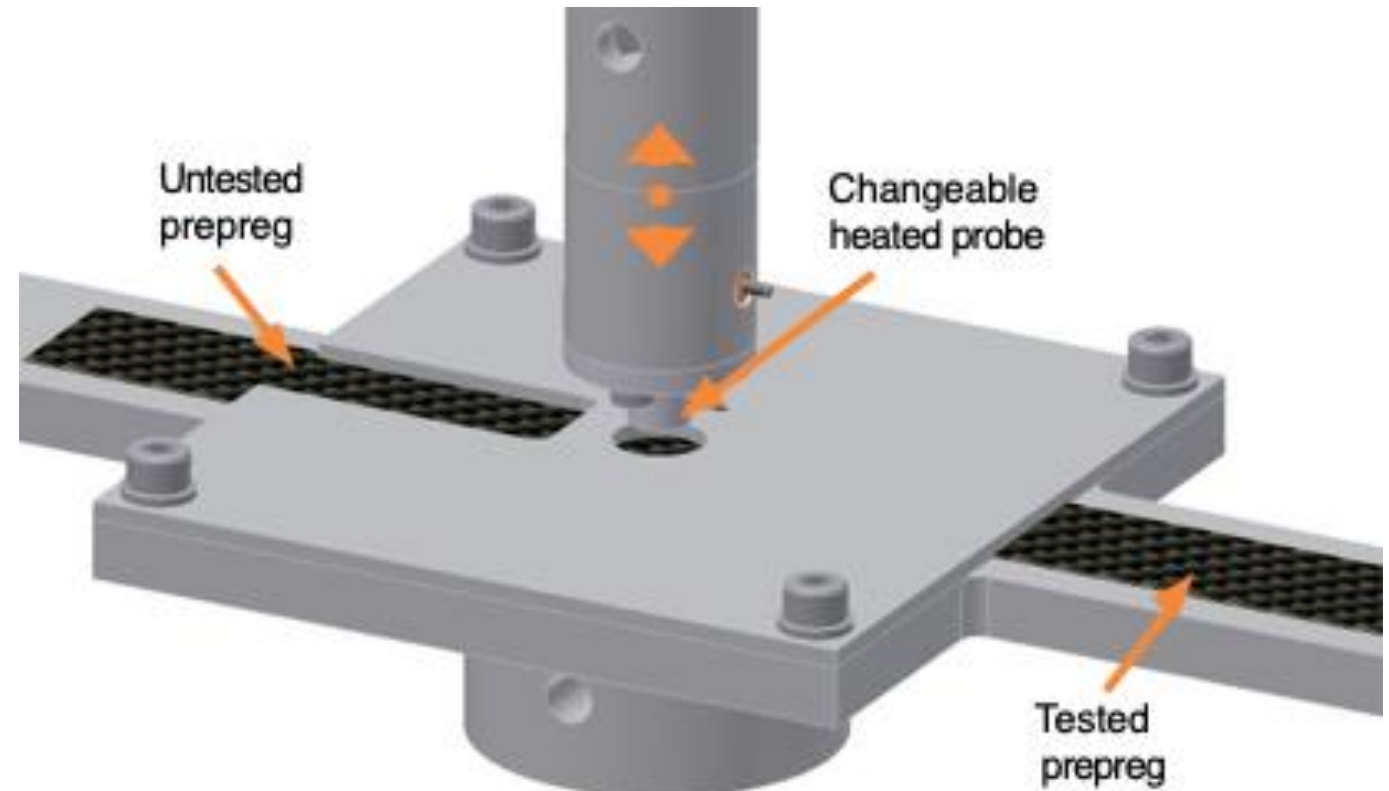
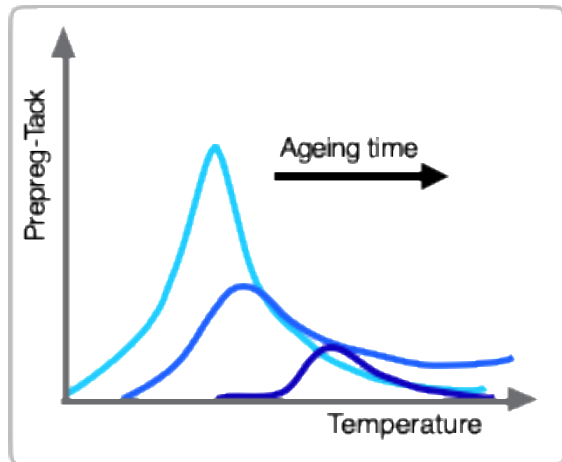
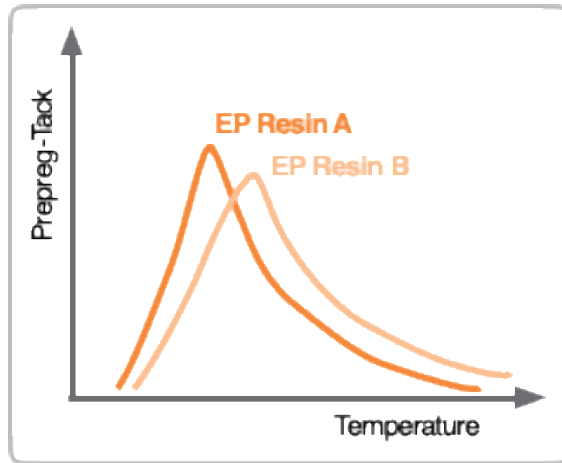
- Aerial weight
- Resin content
- Resin flow (acc. to DIN, ASTM and IPC standards)
- State of impregnation
- Tack properties



Bildquelle:  
Zoltek

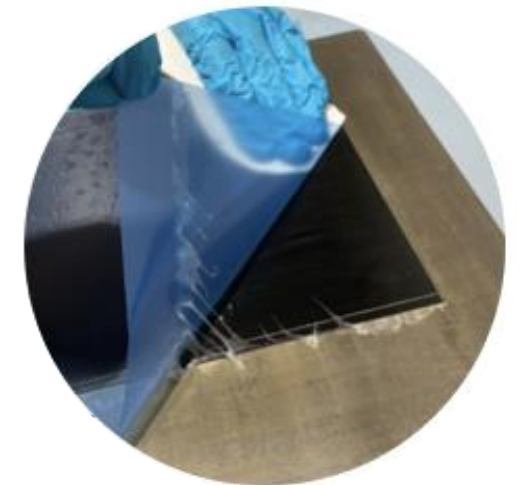
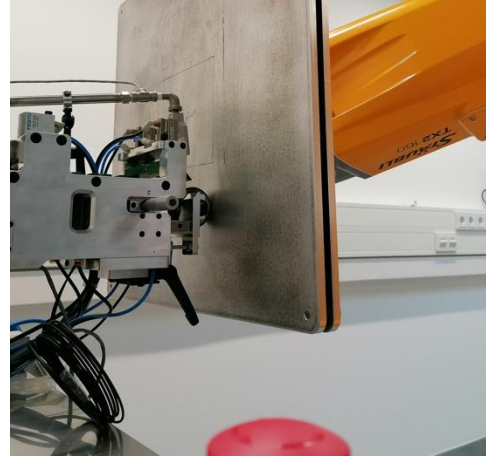
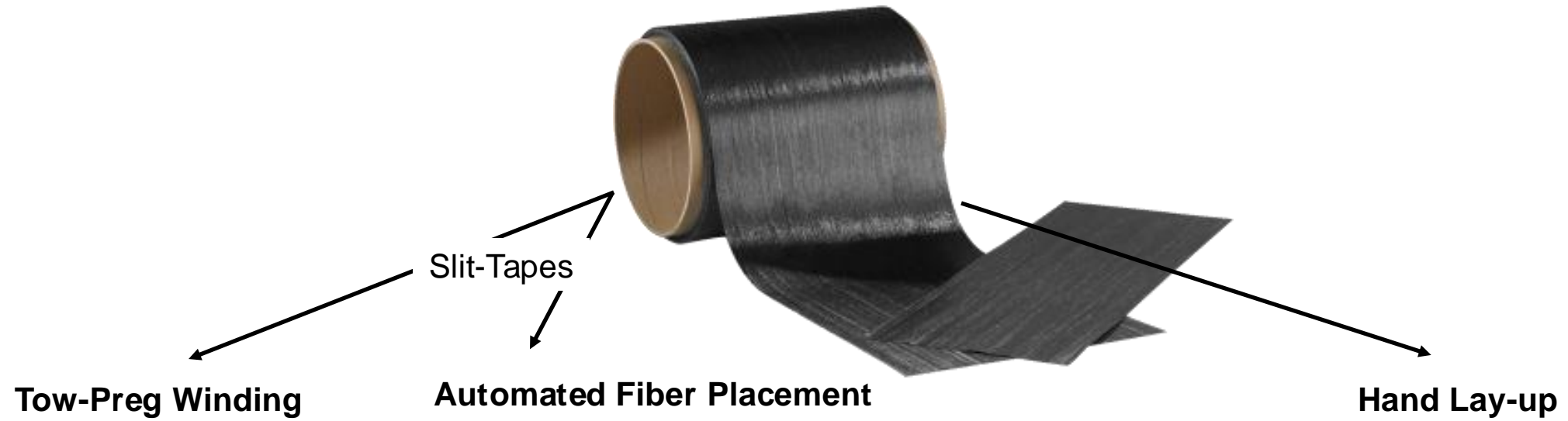


# Characterization of Tack Properties



Tack is a major material property for automated as well as for manual fibre placement applications.

## Production processes





## Curing processes

Out of Autoclave



### Hydraulic Heating Press

- Press area: 60 x 60 cm<sup>2</sup>
- Press capacity: 1000 kN
- Temperature range: 25 to 250 °C

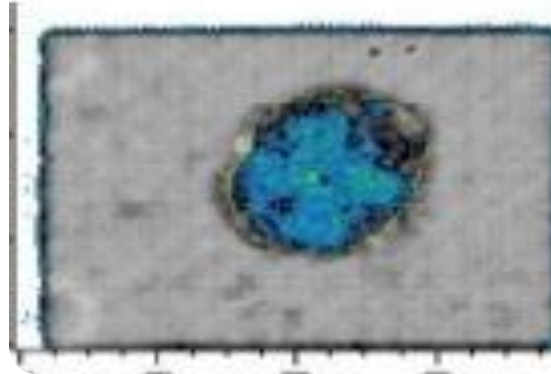
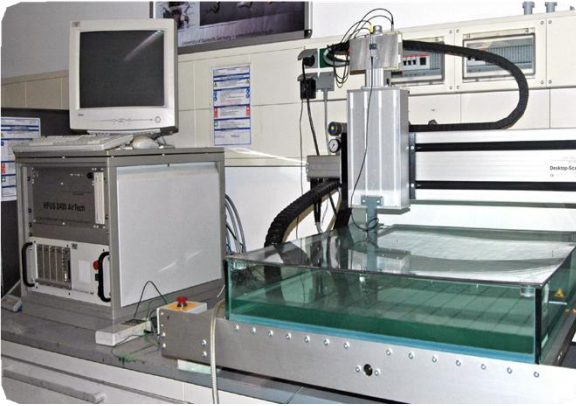
Autoclave



### Autoclave

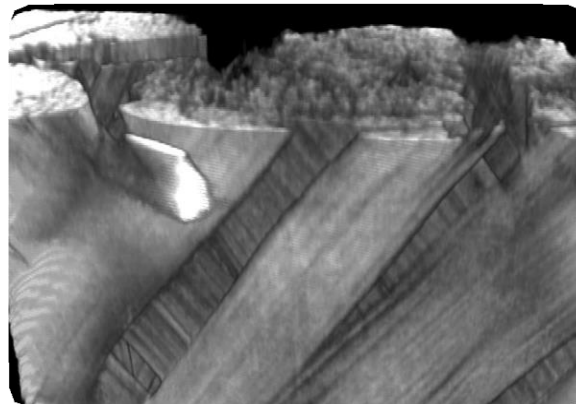
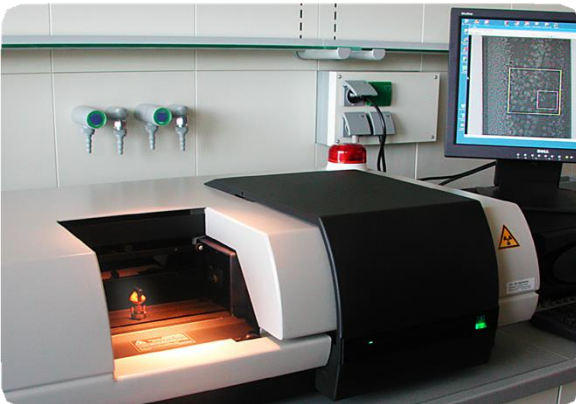
- Pressure range: 8 bar
- Temperature range: 25 to 200 °C
- Working area: 67 x 80 cm<sup>2</sup> (diameter x length)

## Non-destructive Testing



### Ultrasonic Testing

- Quality Assurance
- B- and C-Scan Mode
- 3D Visualization



### Micro-CT

- max. resolution: 5  $\mu\text{m}$
- Porosity
- Fibre wetting

## Mechanical Testing Center

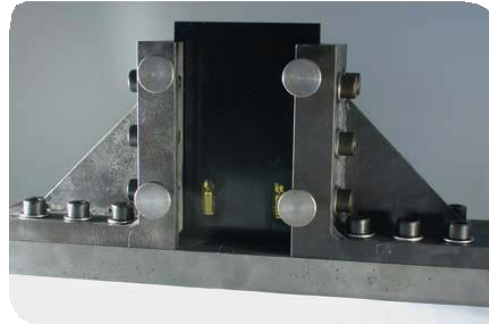




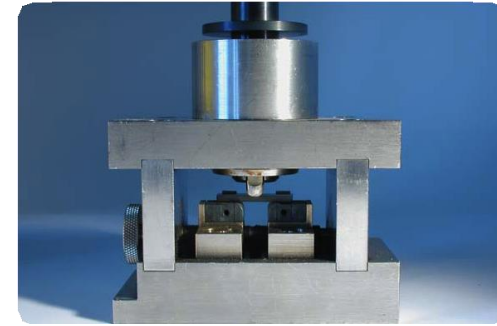
# Composite Testing – Mechanical Characterization



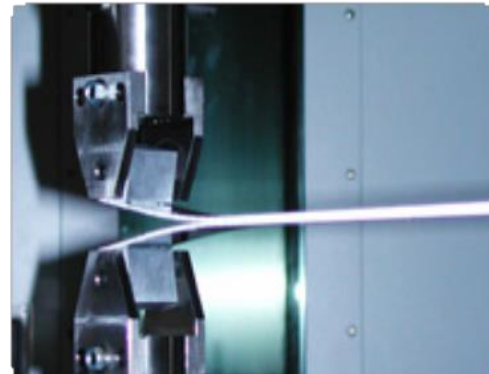
Impact



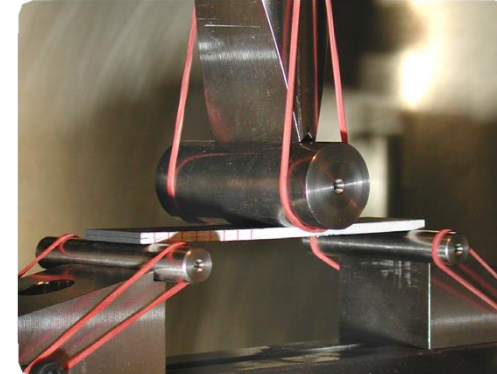
Compression after impact



ILSS

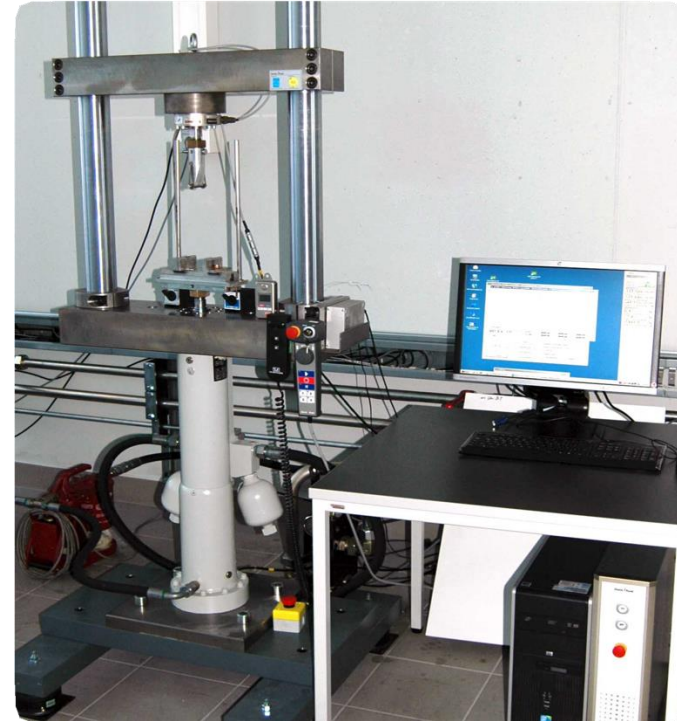
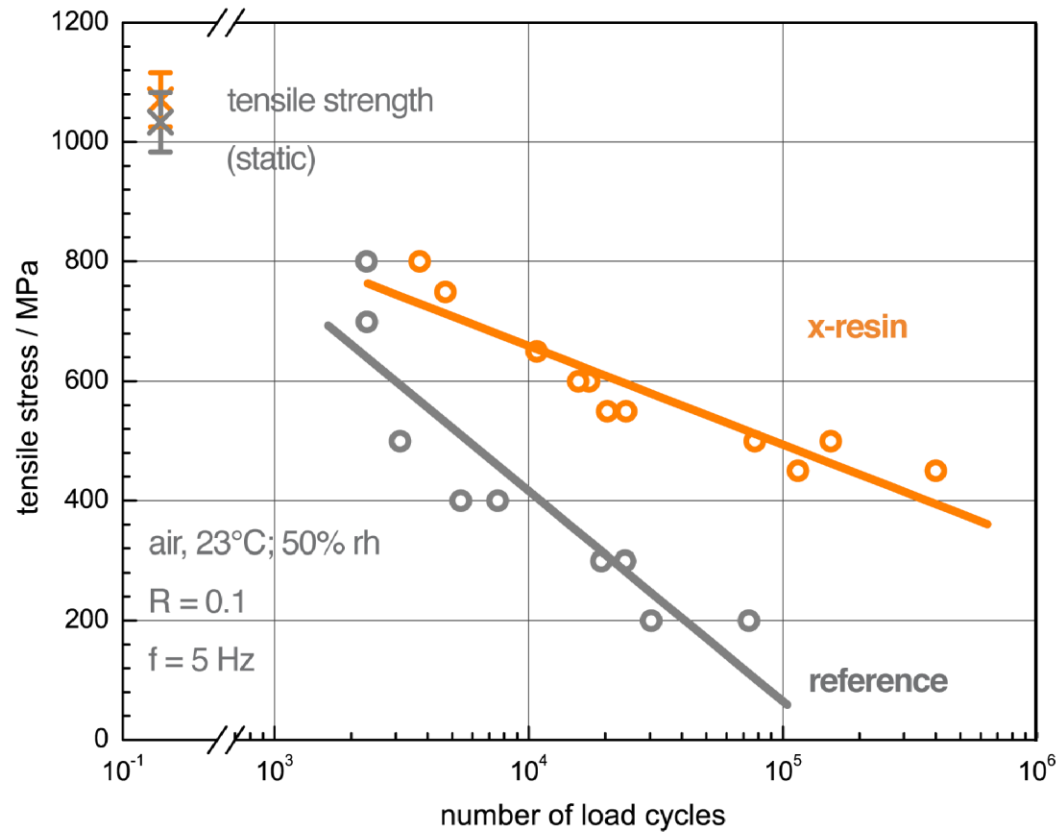


Interlaminar fracture toughness mode I & II





## Dynamic Testing of Composites



- 7 servohydraulic testing machines. Maximum dynamic load: 40 kN
- 1 Multi-axial Electrodynamic Testing Machine. Maximum dyn. load: 10 kN

# How to Cooperate?

- Public funded research projects in cooperation with industrial partners
- Direct industrial cooperation
- Material development
- Evaluation of processability
- Production of sample material
- ...



## Contact:



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Composites

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