



Project 6.5 Development of rCF Thermoplastic Non-woven Prepreg for Automotive Class A Body Panels via Compression Molding

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INNOVATION

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Outline

- Project overview & partners
- Defining & measuring Class A
- Why are Class A thermoplastic / CF composites a challenge?
- Steps toward Class A
- Results & Conclusions

Project Overview & Partners

Goal: Develop a rCF / thermoplastic composite with a Class A painted surface suitable for high volume manufacturing of an automotive body panel



Resin formulation
Non-woven sourcing
Painting
Surface measurements
Class A targets



RocTool installation
Composites processing
Mechanical testing



Mechanical testing
Non-wovens consultancy
Standard tool benchmark

Class A

■ Class A surfaces requires a minimum level of smoothness & defect free

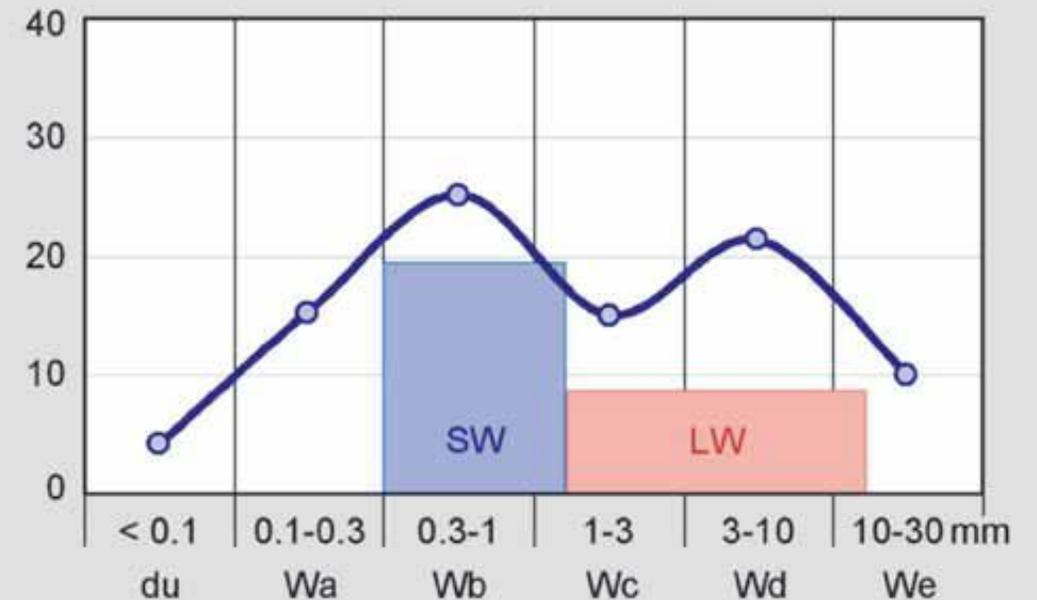
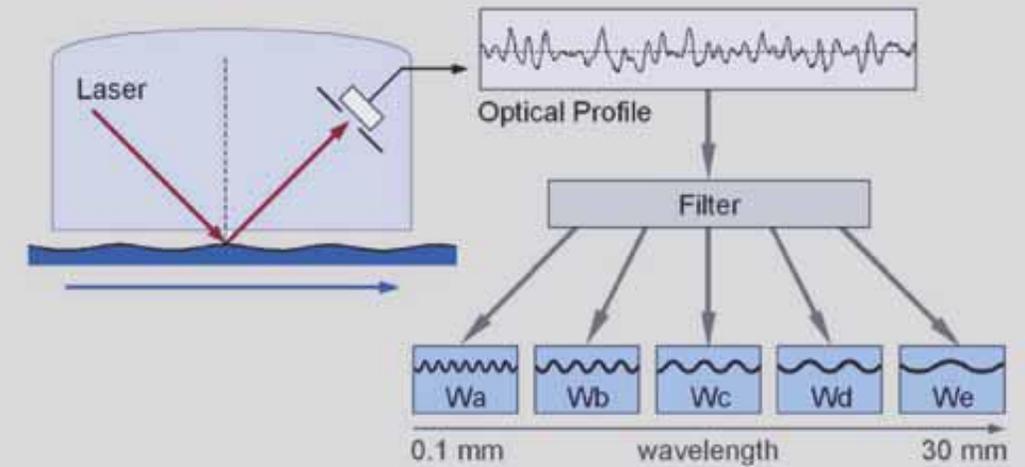
▶ Smoothness \equiv surface topography of painting part

- Each OEM has different specifications – a function of short wavelength (SW) & long wavelength (LW), panel orientation, color, standard vs premium model,...
- Measured with BYK Wavescan tool for high gloss surface

▶ Topography of painted part will depend on topography of substrate

- Benchmark is a primed, e-coated cold rolled steel (CRS) panel
- Carbon fiber / thermoplastic composite topography changes during cooling
 - **Challenge for paintability!**

*BYK-Gardner GmbH

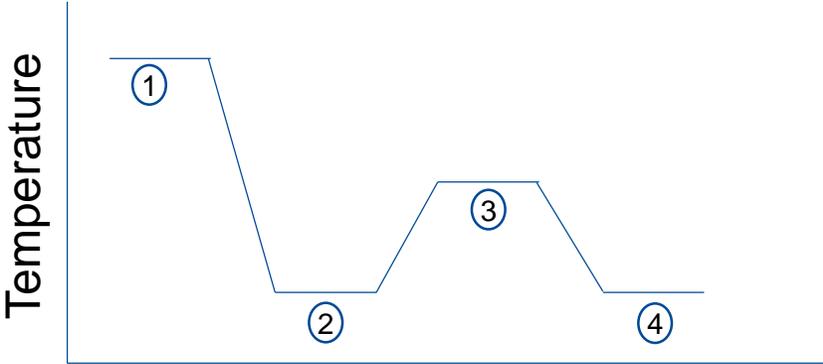


Manufacturing CF/PA Composite Panels

Challenge: Surface topology changes because of thermal expansion mismatch of PA & CF

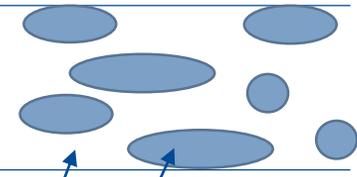
PA CTE: 70-100 $\mu\text{m}/\text{m}\cdot^\circ\text{C}$

CF CTE: 5-10 $\mu\text{m}/\text{m}\cdot^\circ\text{C}$



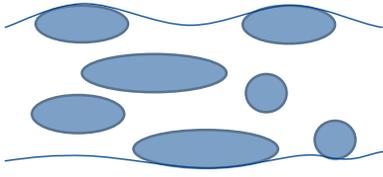
Generic Manufacturing Process

Molding Temp
(+250°C)

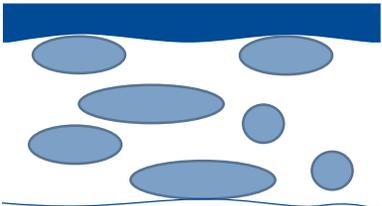


Resin
Carbon Fiber

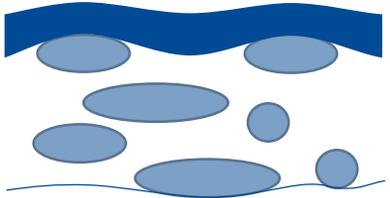
Molded Composite
Room Temp (25°C)



Painted part,
Bake Temp (80-120°C)



Painted part,
Room Temp, (25°C)



Carbon Fiber Non-woven Preform



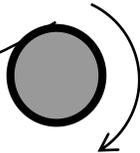
BASF Ultramid® PA6
Spun & Chopped



Recycled
Carbon
Fiber



Comingling &
Roll Forming
Process



Comingled roll product
(300-400 gsm)

Why we chose non-wovens:

- Recycled feed stock
- Random (mostly) in-plane orientation
- Long fibers
- Good mechanical properties
- Low bulk CTE

Challenges:

- Reformulation is lengthy
- Consistent quality
- Fiber dispersion

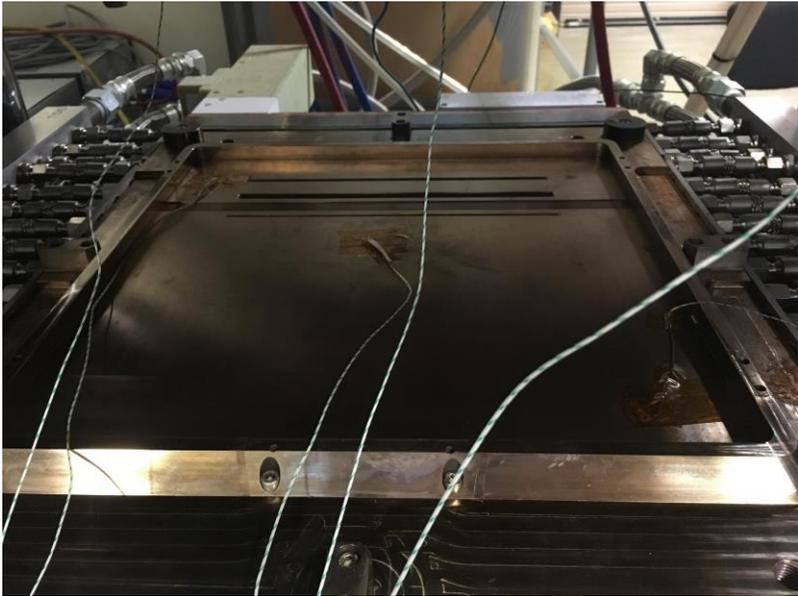
RocTool Process

- Rapid Heating & Cooling Technology
- Proven High-Quality Surface Finish



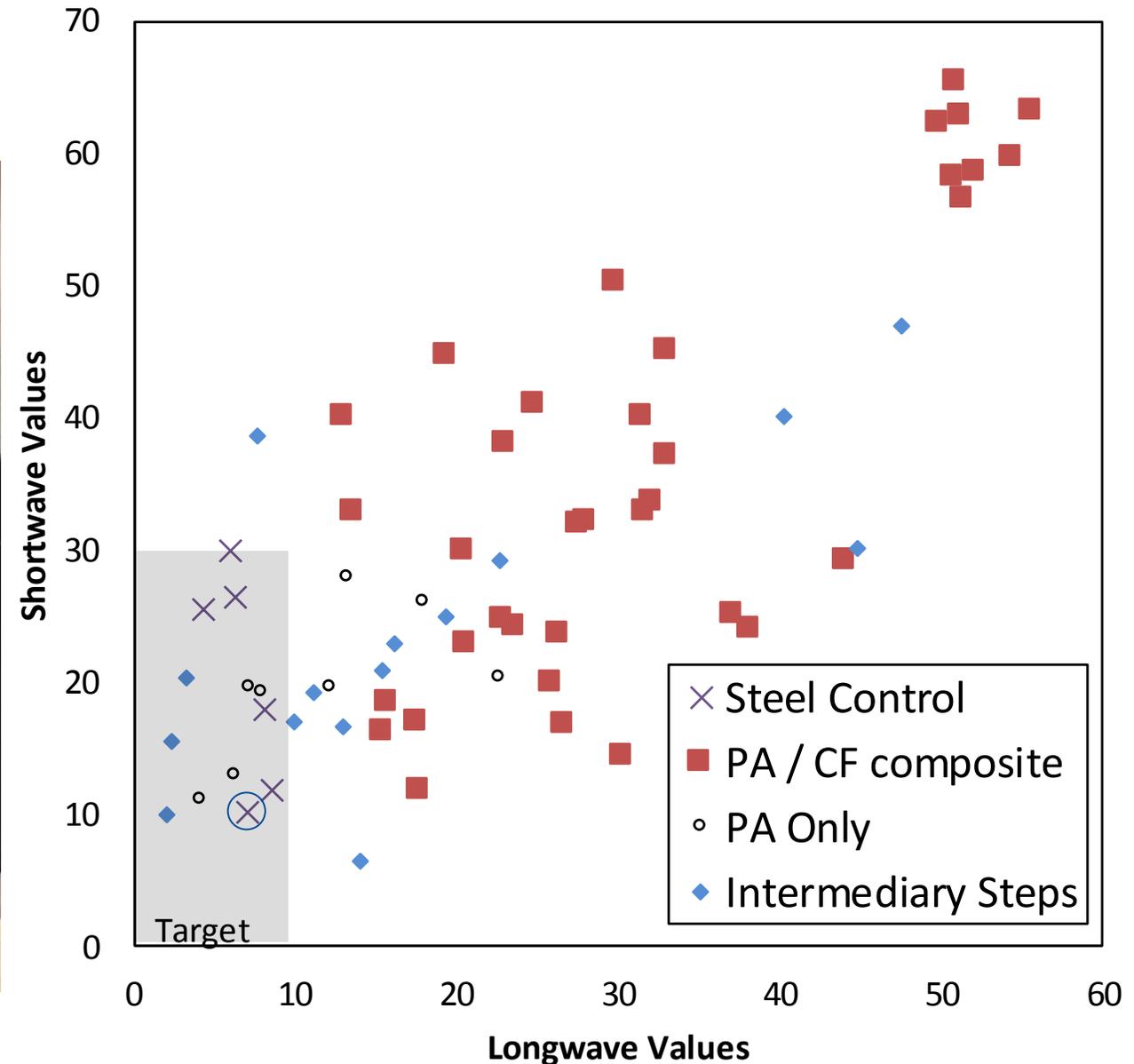
*Injection Molding (w/o carbon fiber) standard (Left), RocTool (Right)

(photo from Kraussmaffe)



Results

- ✘ **Steel Control** – produced during each painting trial
- **PA / CF composite** – intended part
- **PA Only** – painted PA panels to verify manufacturing process meets Class A
- ◆ **Intermediary steps** – experiments to develop fundamental knowledge & would knowingly not meet all targets

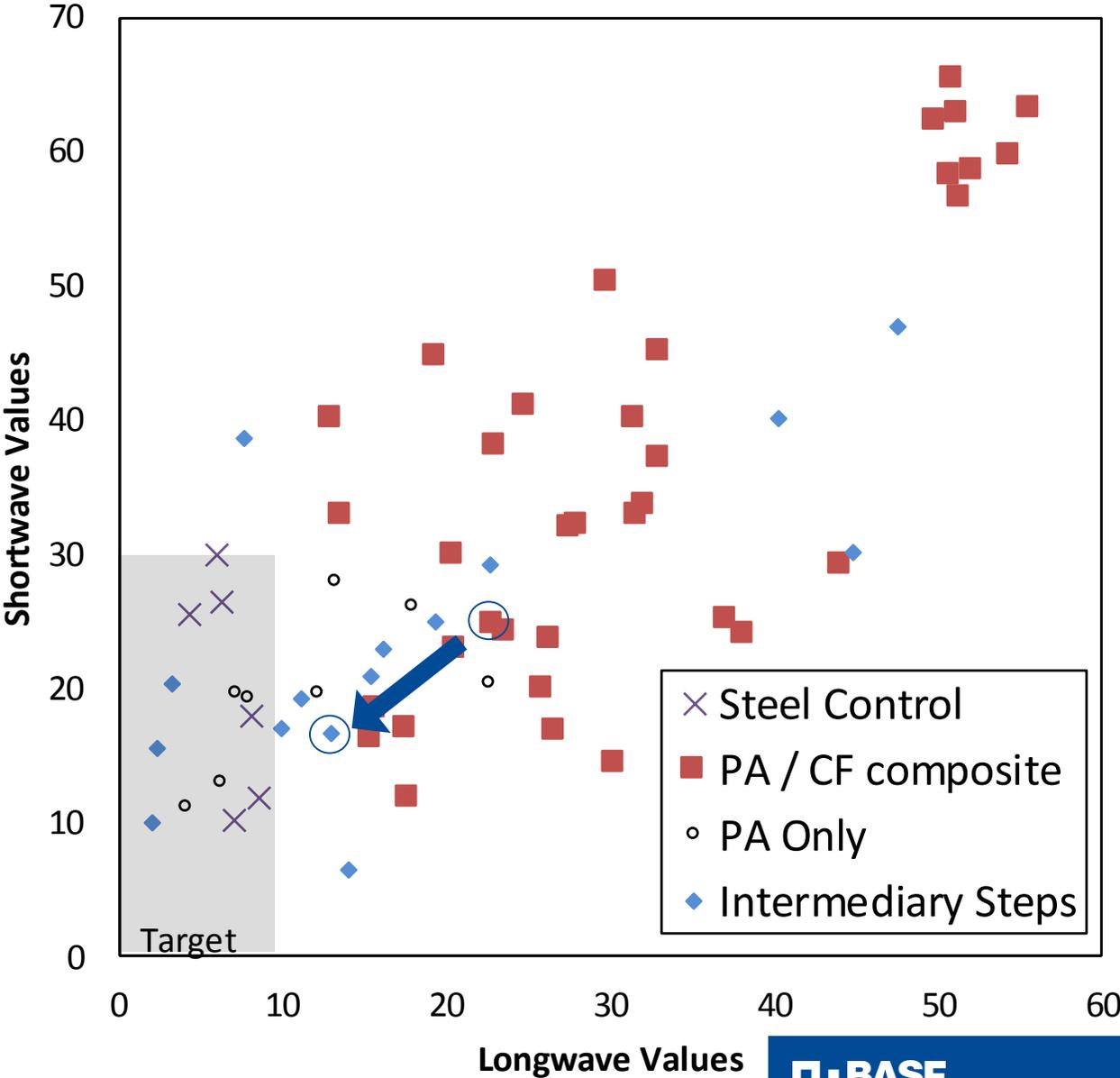


Dynamic Substrate Topology

■ Effect of reheating painted part to 80 °C

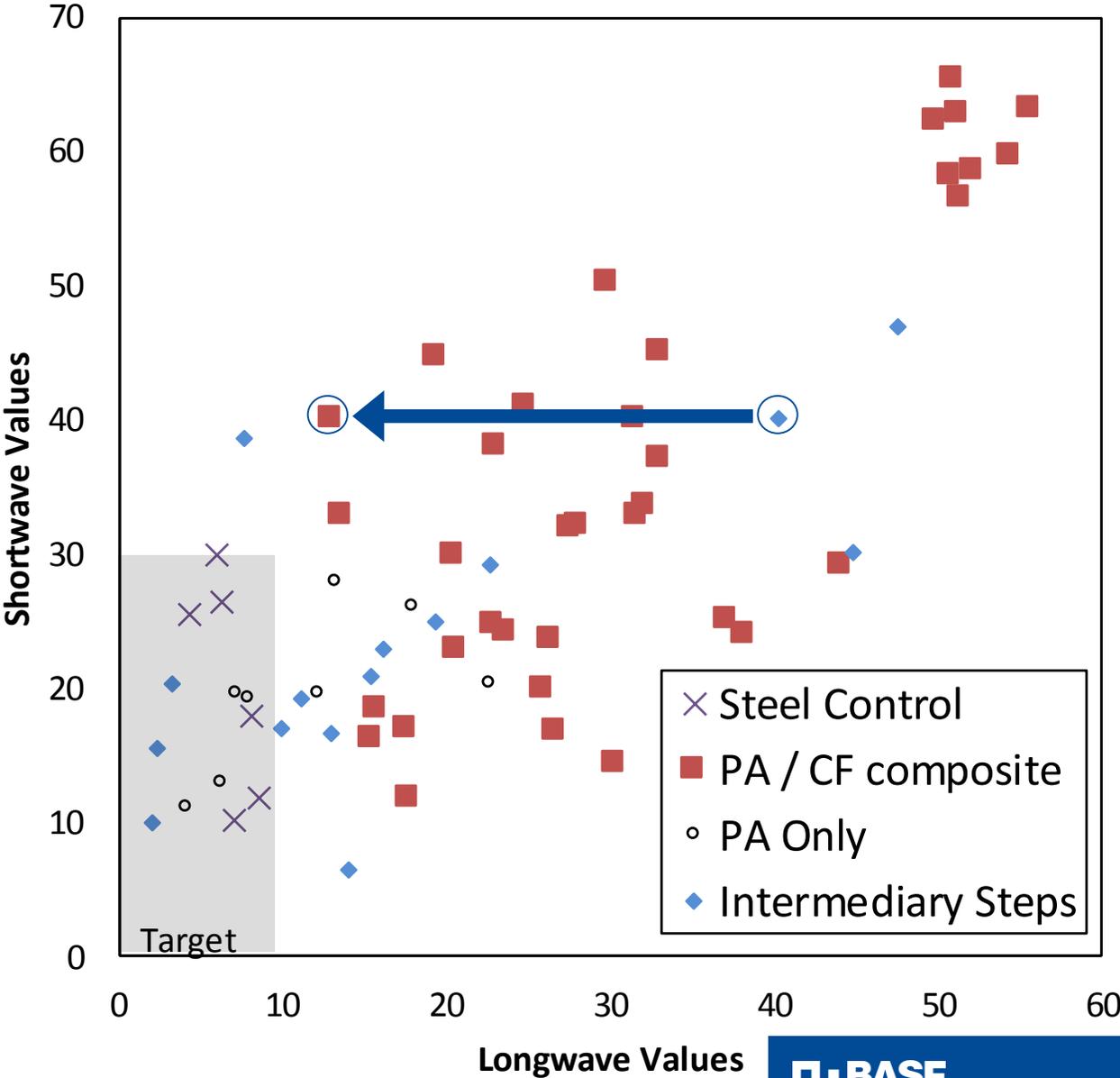
At ~80 °C ◆

At 25 °C ■

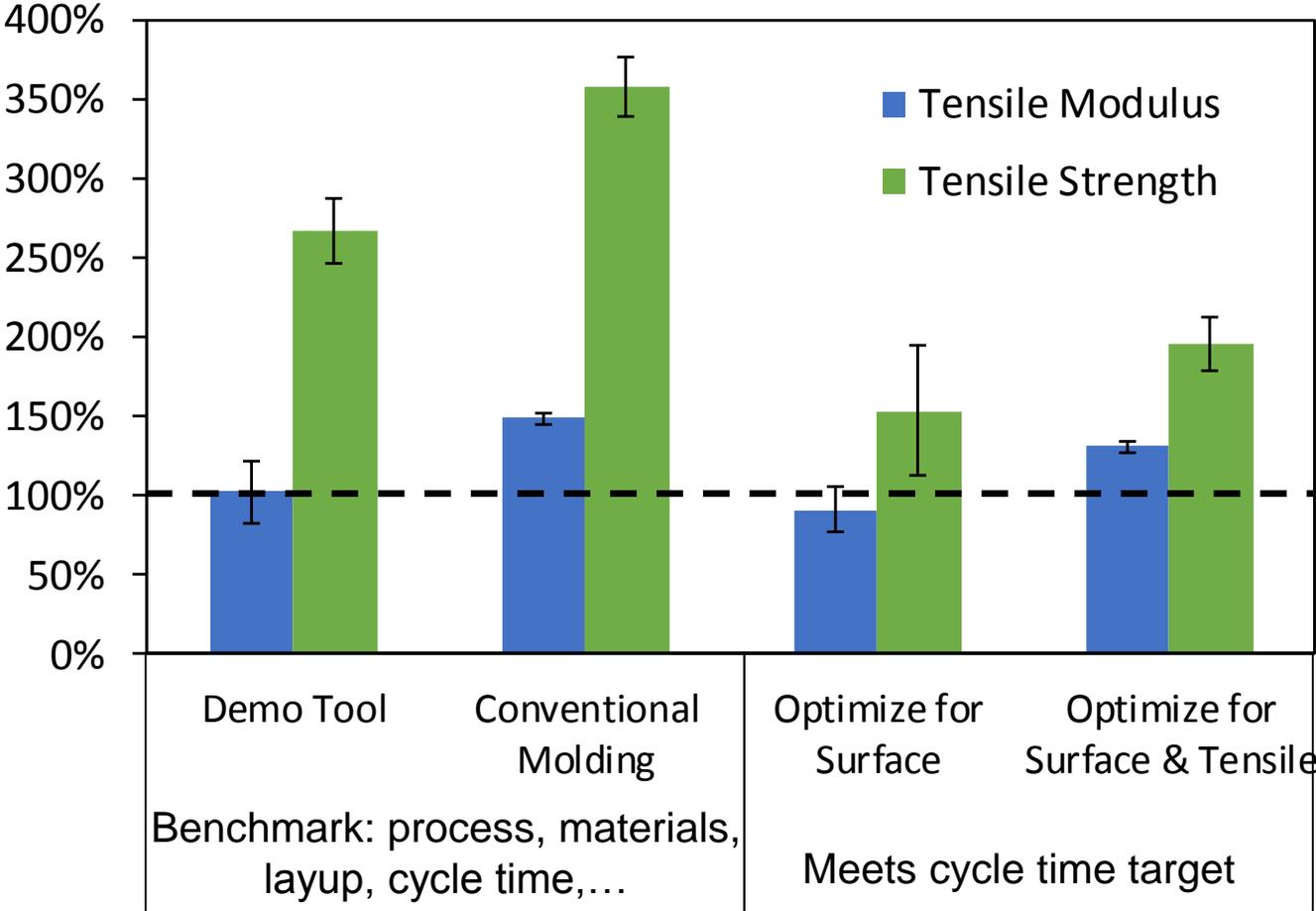


Smoothing Surface Topology

■ Surface quality before and after painting



Mechanical Properties

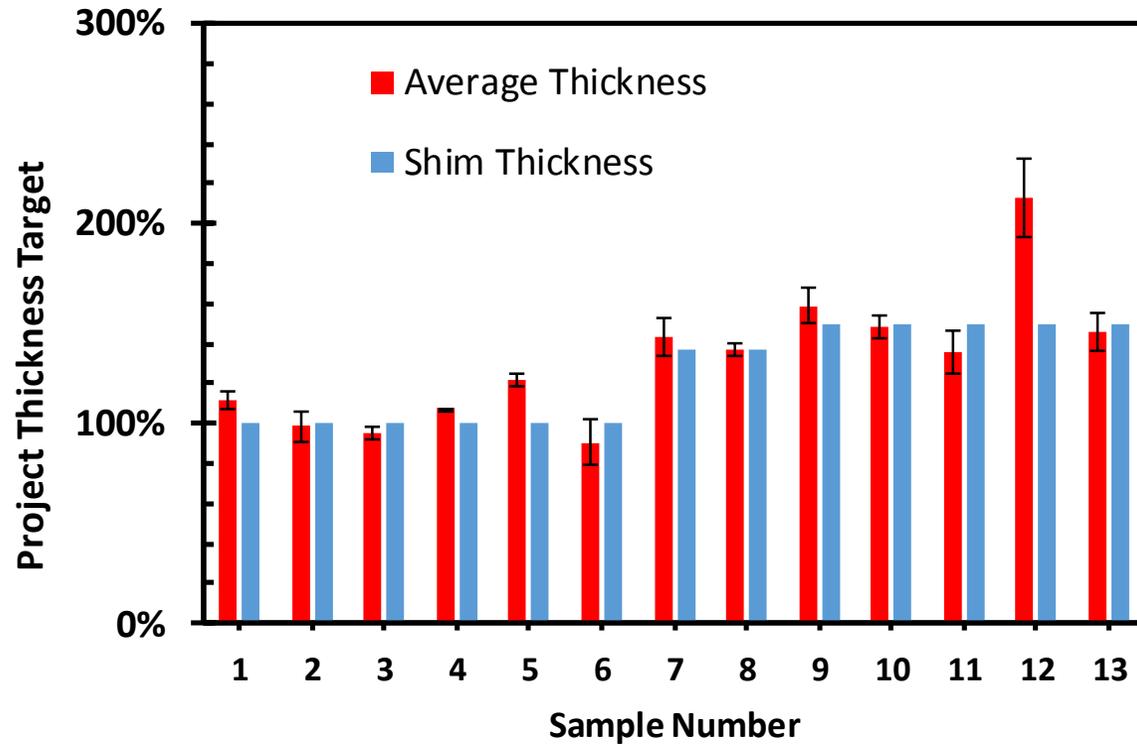


Challenge:

Fast cycle time vs. full consolidation
+ ...

- High quality surface
- Defect free
- Target part thickness
- Repeatable process

Thickness Characterization



- Target thickness allowable variance +/- 6.5%
- Large variations in part thickness were a result of large variations with incoming material

Conclusions & Outlook

- Class A painted surface is feasible for PA / CF composite!
 - ▶ Preliminary targets:
 - Mechanical performance achieved
 - Cycle time @ specified thickness achieved
 - Surface Quality (SW achieved, LW close)
- A combination of materials and processing protocols allow for the dynamic surface topography to be managed
 - ▶ Path forward identified to reach LW target



We create chemistry