Composites in Automotive : Great hope for the car of the future and enormous challenges to face

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March 31, 2015

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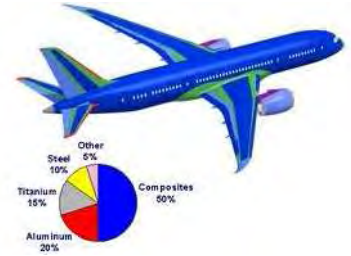
Composites materials : Interest and advantages

Strength, stiffness and lightweight



- **Strongly developed for commercial aircrafts for more than 20 years**
  - Increasing the autonomy
  - Reduction of fuel consomption

Airbus A380 - 2007
Composites = 25% in mass

Boeing 787 Dreamliner- end of 2011
Composites = 50% in mass

Airbus A350 XWB - 2013
Composites = 53% in mass

- **Could be an opportunity for automotive**
  - Emissions and pollution reduction : CO2 – worldwide regulation 2020 - 2025
  - Lightweight solution for hybrid or electrical cars

Composites in automotive

Some brands have developed composites solutions

- **Sport or premium cars**

McLaren MP4 12C – 150 K€

TESLA Roadster – 85 K€

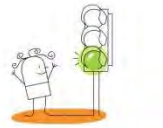
ALPHA 4C – 51 K€

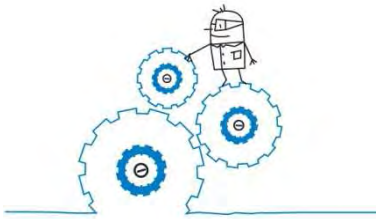
- **Electrical cars**

BMW I3 – 37 K€

But this does not extend to serial cars !!!

What are the challenges ?





Cost efficiency

- Maximum cost :between 4 and 5 €/kg saved
- Composite GF-PA66 : 3,5 €/kg
- Carbon fibers : Target 8€/kg

Industrialisation, short cycle time and compatibility with existing technologies

- Mass production : 100 000 parts/year => 2' cycle time

  200 000 parts/year => 1' cycle time
- Hybrid metal-composites assembly
- Compliant with the existing industrial plant (assembly and painting)

Recycling and sustainability

- Recall : recycling rate in weight = 95%

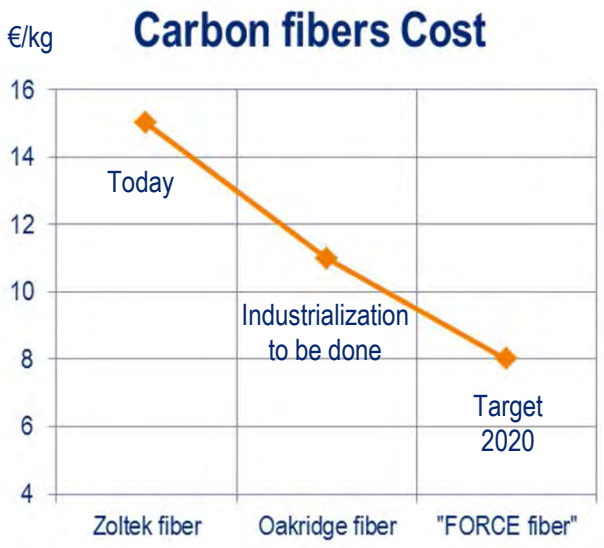
Predictivity and numerical simulation

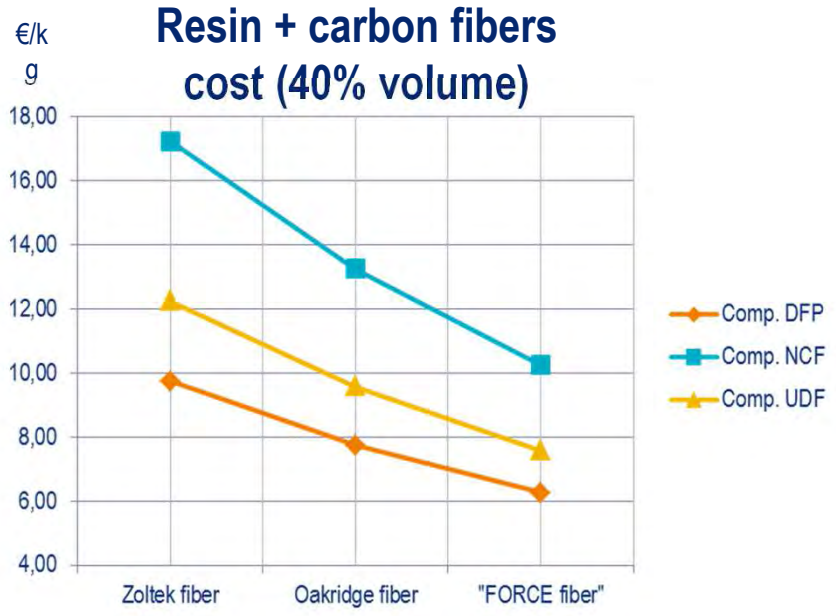
- No more prototype - Respect of the car development time
- Numerical validation expected according to specifications (crash)
- Composites Chair : Faurecia-ECN

Cost efficiency : Examples of economical carbon fibers

Faurecia is involved in 2 specific projects

- a short term one, evaluation of a Low Cost Carbon Fiber develop by OakRidge National Laboratory in USA (DOE), end 2015
- A long term one, a French collaborative project FORCE (Fibre Optimisée Réaliste Carbone Economique), end 2020.





Cost efficiency : OakRidge carbon fibers

Partnership

OAK RIDGE National Laboratory

Pilot line for Low Cost Carbon Fibers

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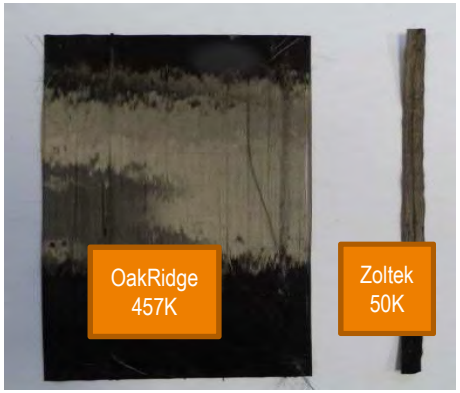
Manufacturing :
Direct Fiber Preforming process
Resin Transfer Molding process for molding

CHOMARAT

Non **C**rimp **F**abric maufacturing

Low Cost Carbon fiber description

Precursor: PAN usually used for textile purpose as coverlet (most of the time the precursor is manufacture for carbon fibers).
457K tow but with a filament diameter of 5µ.



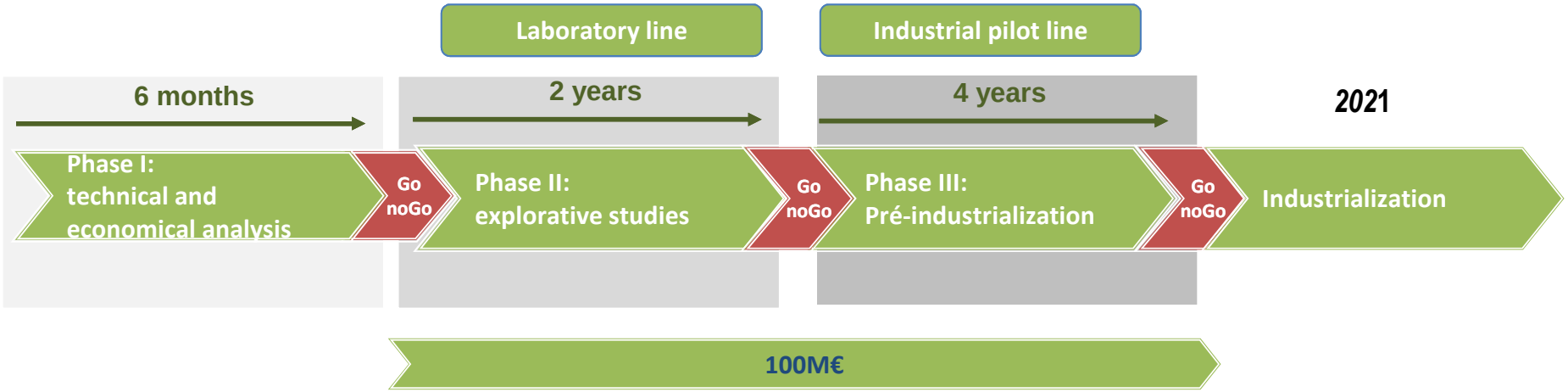
	Oak Ridge	Zoltek PX35	Diff. %
€/kg	11	15	-27%
E GPa	224	242	-7%
σ MPa	3275	4100	-20%

Properties in line with automotive targets:
Modulus, not more than 10% less - Tensile Strength not under 3000MPa

Cost efficiency : FORCE project and partners

(Fibre Optimisée Réaliste Carbone Economique)

Target price < 8€/kg to get a CF composite part at 20€/kg

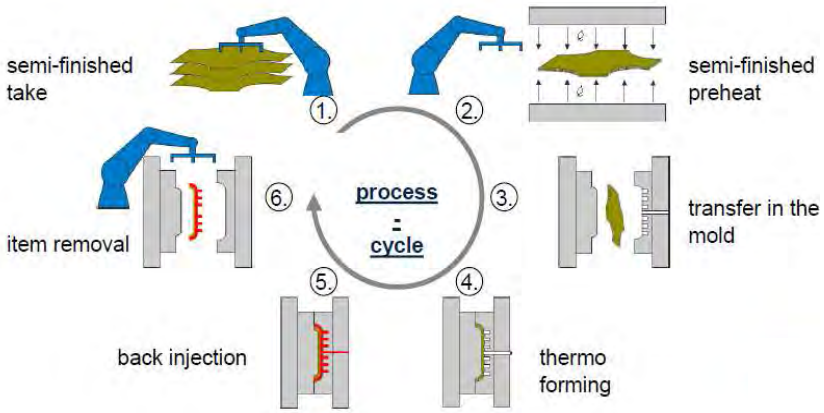


A multi-sector consortium of producer and user industries

Pilot:

Process industrialization : Short cycle time

- One shot process



Industrial line for thermostamping and back injection : 70 sec cycle time

Recycling and sustainabilty

What to do with production waste and parts end of life?

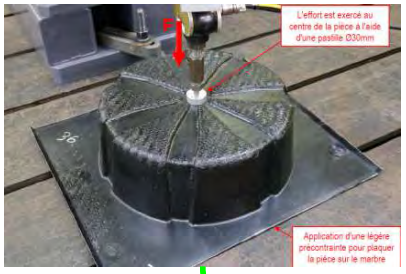
- **Thermoset resin composites**
  - Energy recovery

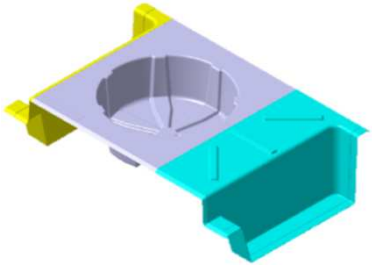
- **Thermoplastic resin composites**
  - Grinding of material and re-injection of reinforced thermoplastic part

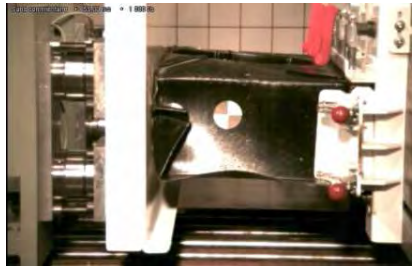
Recycling facilities don't exist
The recycling process must be put in place

Predictivity: Process and product simulation

- From learning mold to Rear floor

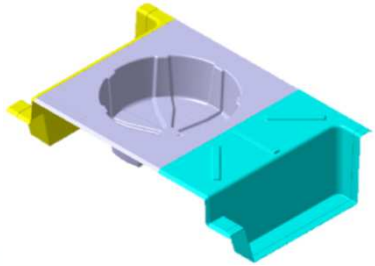




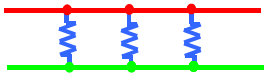


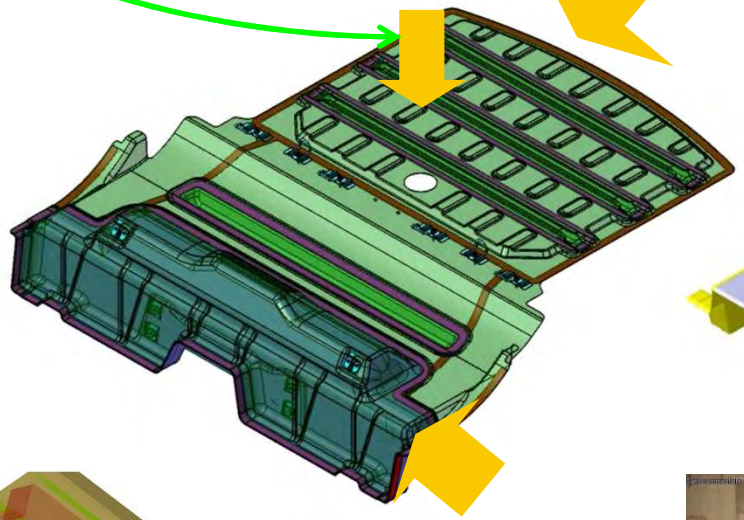
Static Load

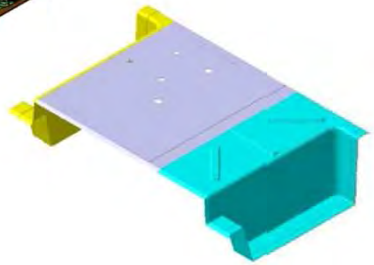
Rear Impact



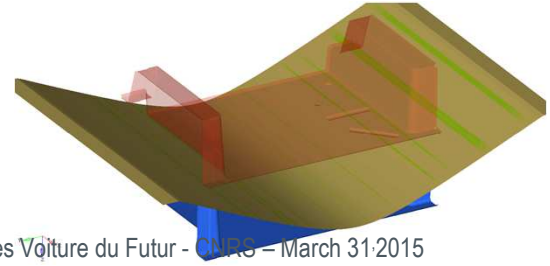
Assembly



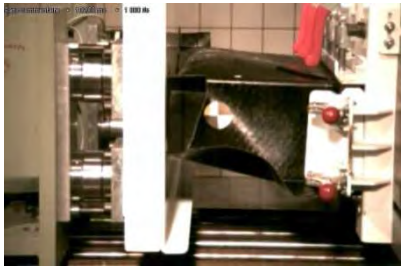




Draping



Lateral impact



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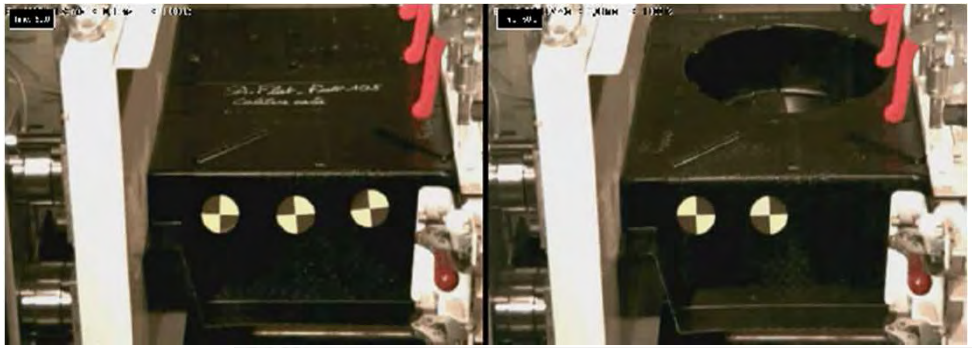
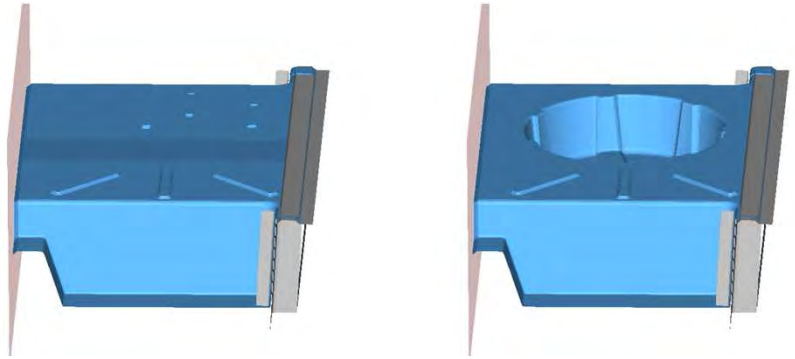
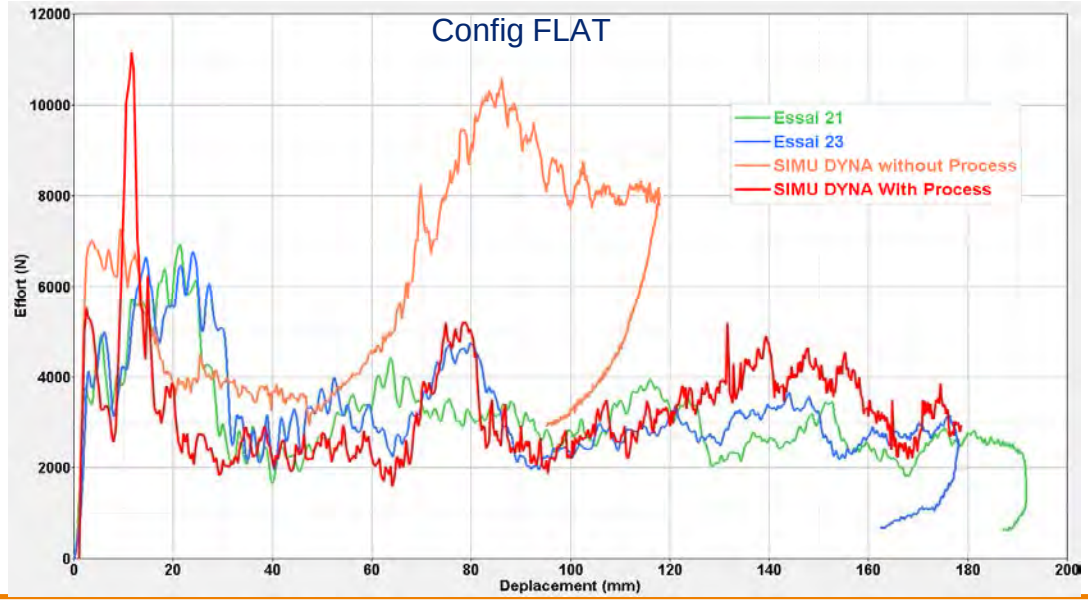
Predictivity: Process and product simulation

- Dynamic characterization & simulation with process coupling







Huge influence of process confirmed on trial tests, regarding product performance

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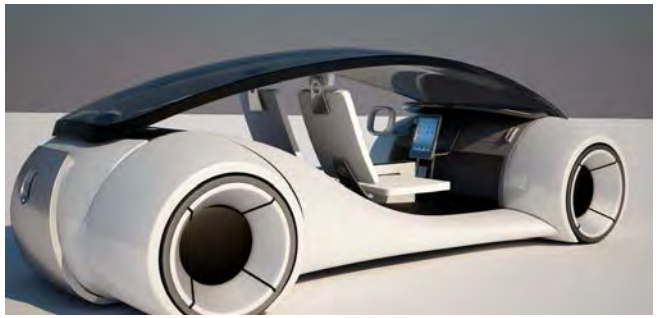
CONCLUSION

- **Introduction of composites materials is not so easy for the current cars**
  - Challenges are huge to compete metallic solutions
  - Constraints linked to the current OEMs manufacturing plant are very handicapping
- **But the composites should be the solution for the « clean car » in 2020-2025**
  - after the metal will be totally improved.
- **Opportunity : the birth of new innovative cars will promote composites solutions**

Google car



iCAR – Apple TITAN

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Technical perfection, automotive passion