FCA
FIAT CHRYSLER AUTOMOBILES

CRF

New materials for additive manufacturing - The automotive perspective

Nano Innovation 2017 Rome, 26-29 September
Conference & Exhibition

Airi ASSOCIAZIONE ITALIANA PER LA RICERCA INDUSTRIALE

Smart Manufacturing in industry 4.0: where we stand?

September 28

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GROUP MATERIALS LABS - Polymers & Glass

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- Transportation sector **materials evolution**
- **Innovation drivers** and AM materials **opportunities in automotive**
- **CRF activities** and AM polymeric materials development strategies
  - Materials in use substitution
  - Materials in use substitution with more performing materials
  - Materials with functionalized fillers
- Conclusions

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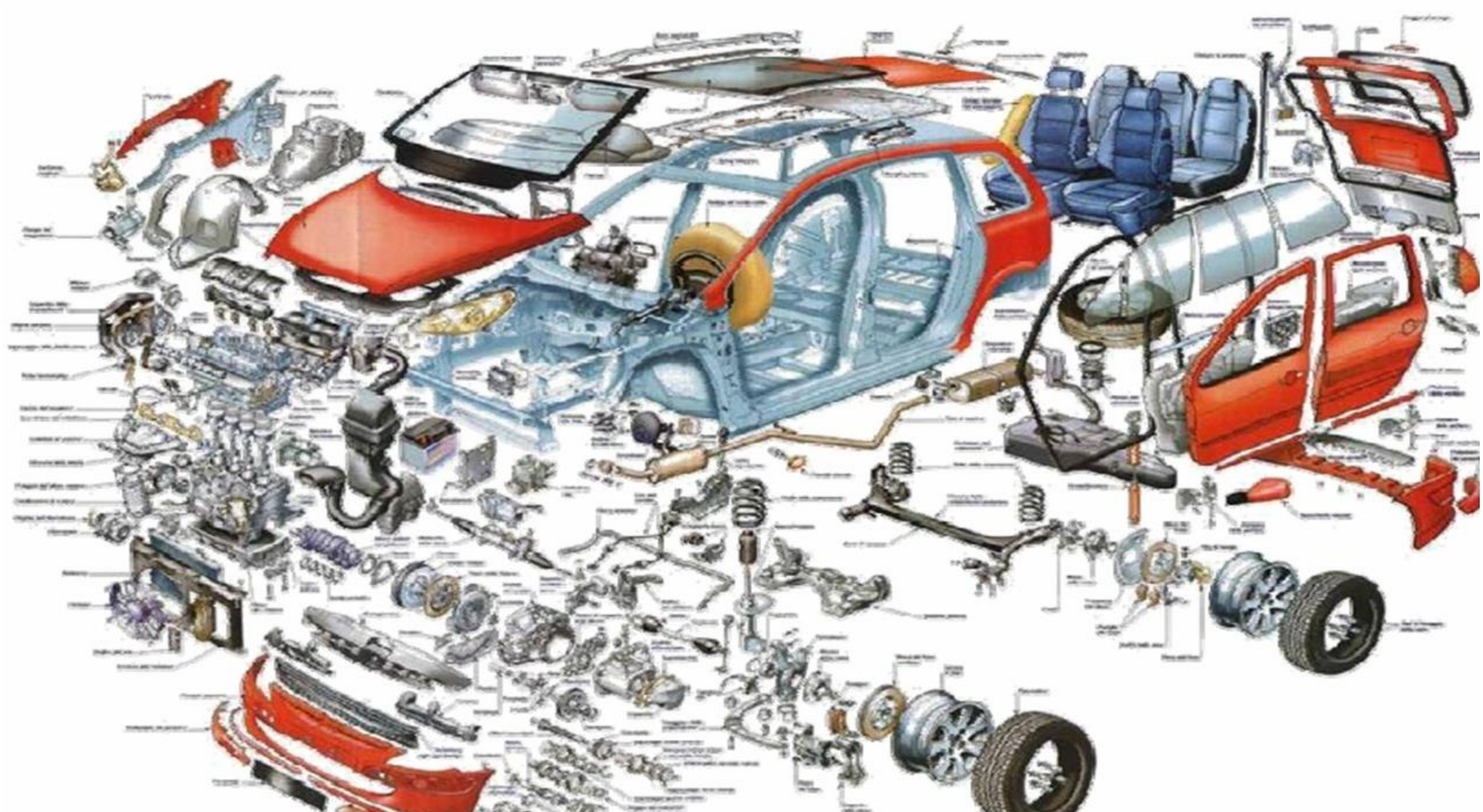
Transportation sector

Very different scenarios…but a global market

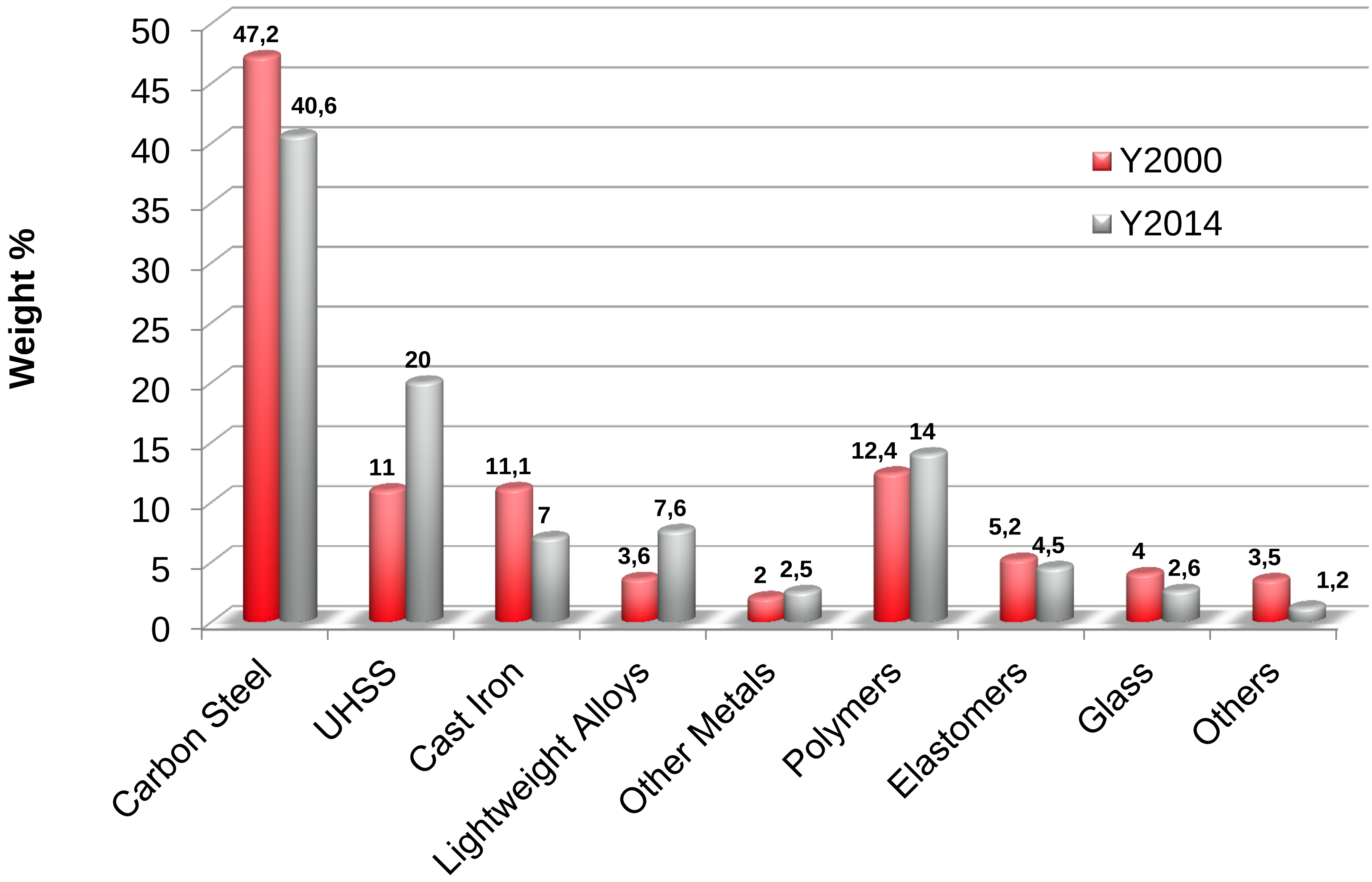
FCA Group (EMEA, NAFTA, LATAM and APAC)

The car evolution

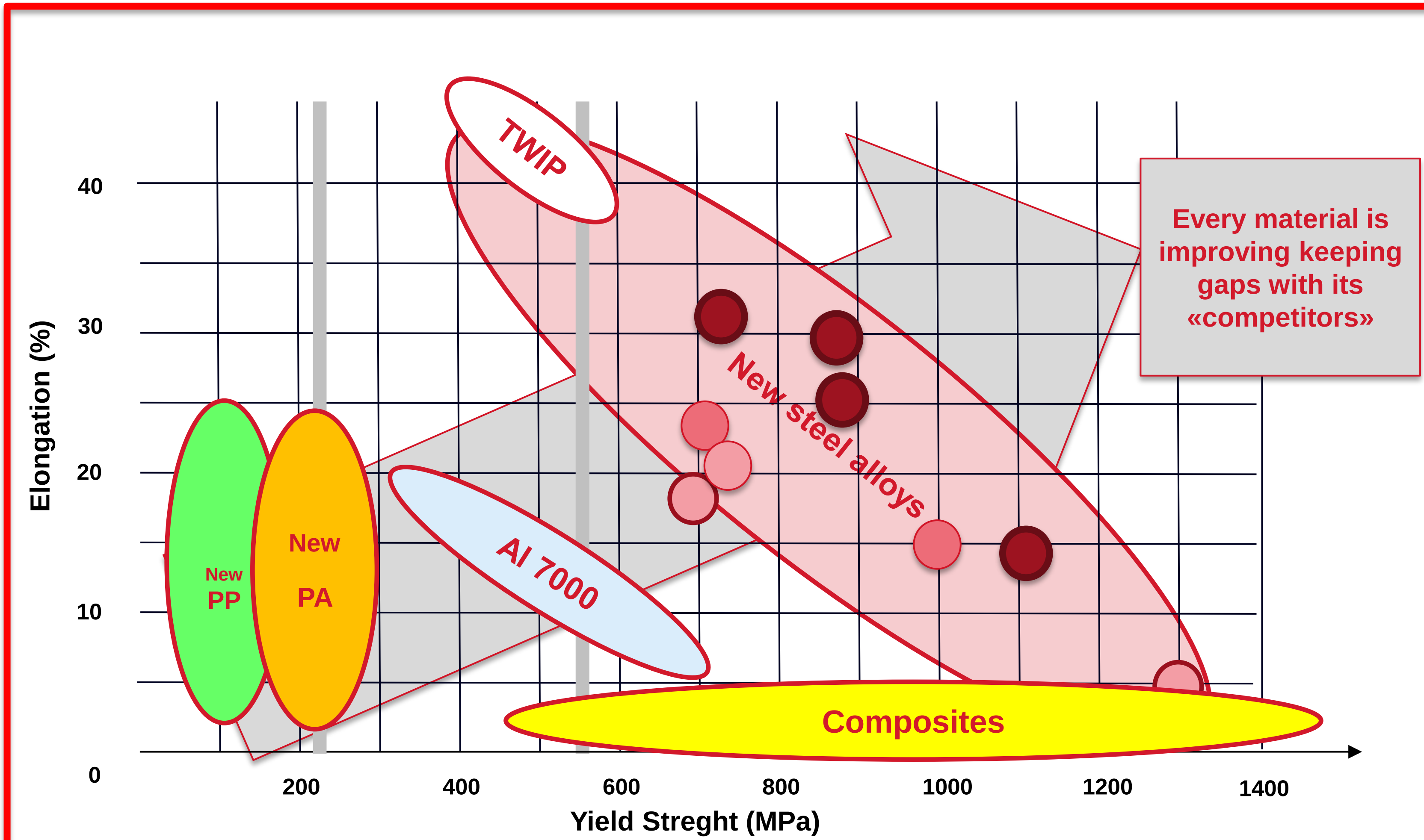


Today the car is **assembled with 15.000 parts**, extremely reliable and optimized in terms of safety and environmental impact, **with the lower cost per kilogram** respect to other high technological level consumer goods.

Materials breakdown evolution



General materials properties



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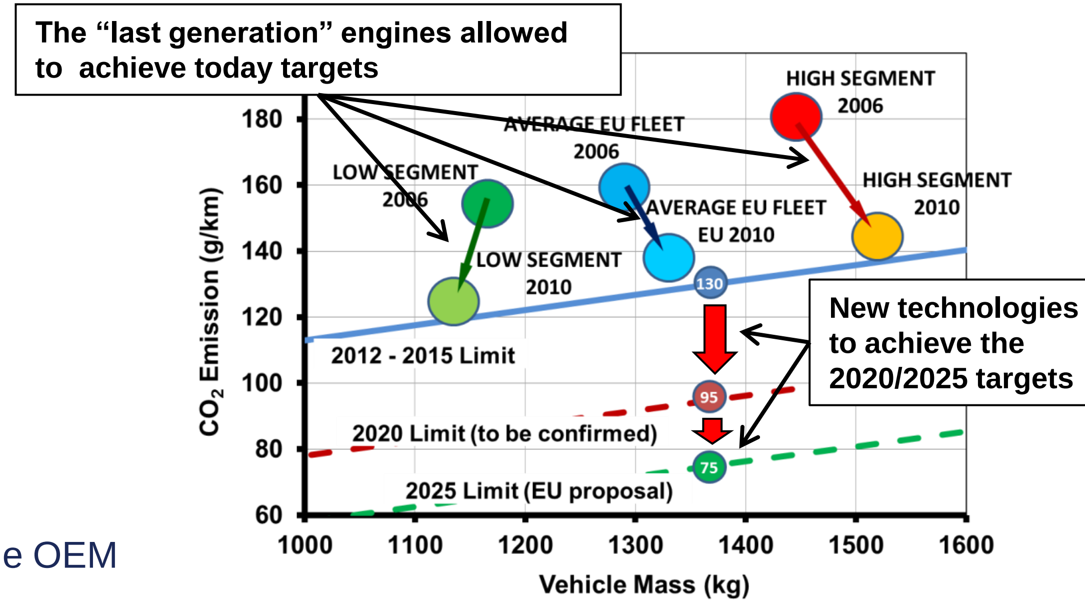
Drivers for Innovations

CO_2 problem / Global warming



Each exceeding g CO_2/km will **cost 95€** to the OEM

Individual customer demands

New style effects and personalization for high **perceived quality**

Limited resources

Environmental friendly materials and **reclying** improvements

AM boost in Automotive Sector

FUNCTIONS

- LIGHTWEIGHT
- INTEGRATION COMPLEX PARTS
- CUSTOMIZATION
- HYBRIDS and MULTIFUNCTIONAL
- SUITABLE APPLICATIONS for BODY, INTERIORS, ENGINE SYSTEMS and UNDER BONNET

VISION

Spare parts and accessories management

Lower costs in development phase

Low volume parts production

CHALLENGES

- Materials range and characterization
- Design strategies
- Manufacturing optimization
- Costs and environmental impact drivers

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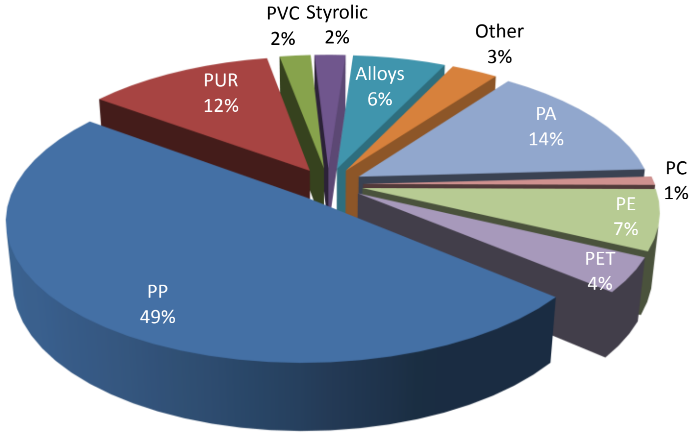
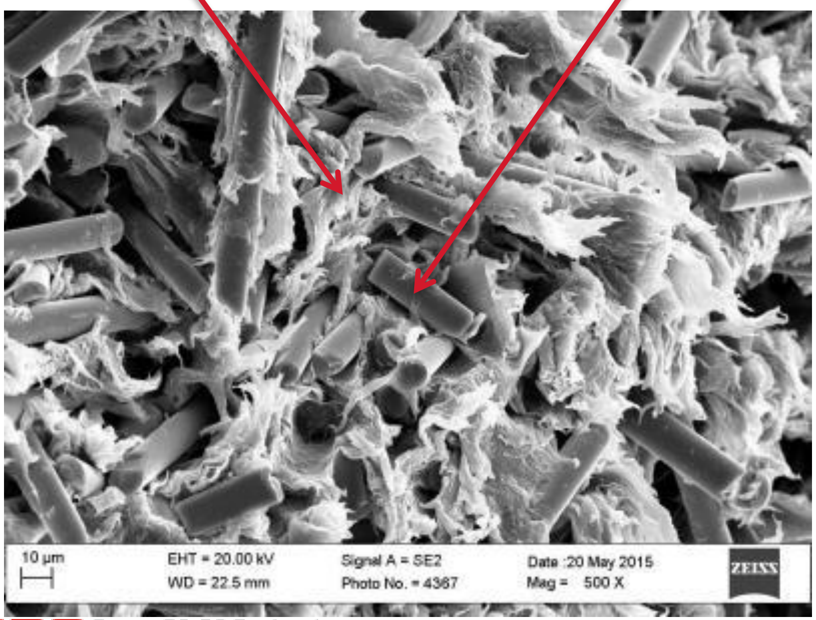
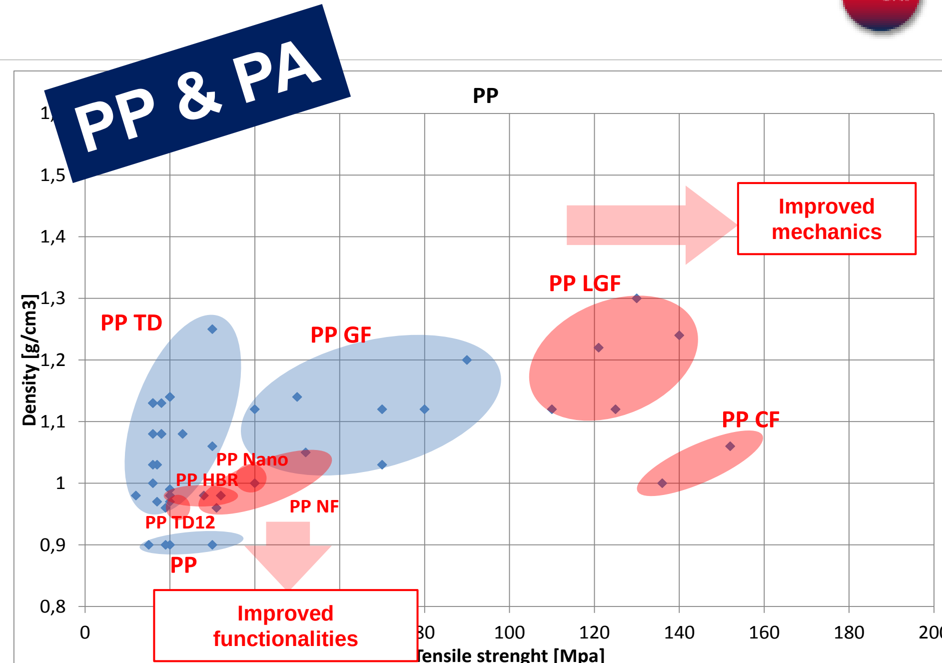
Polymers developments

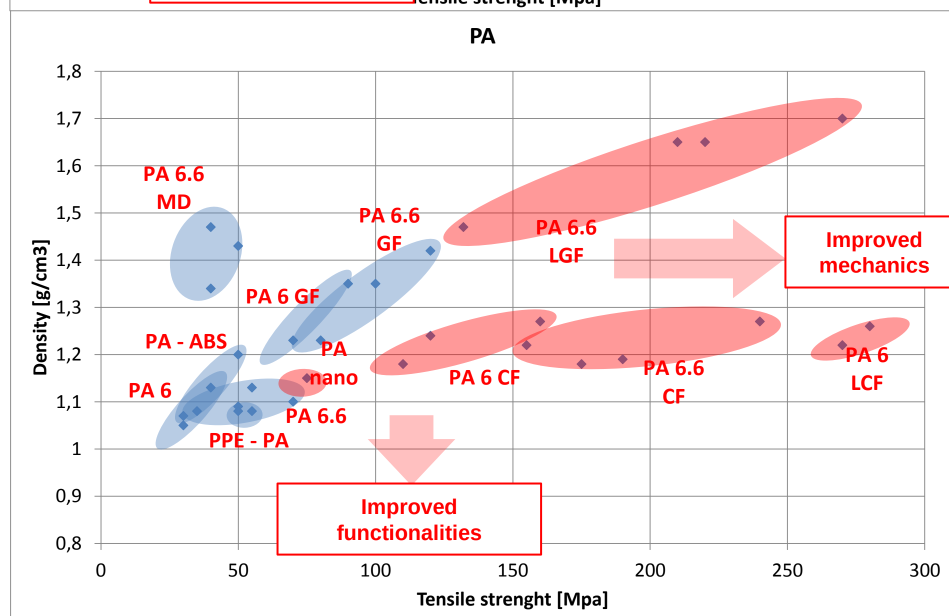


Matrix and additives

Fillers/fibers



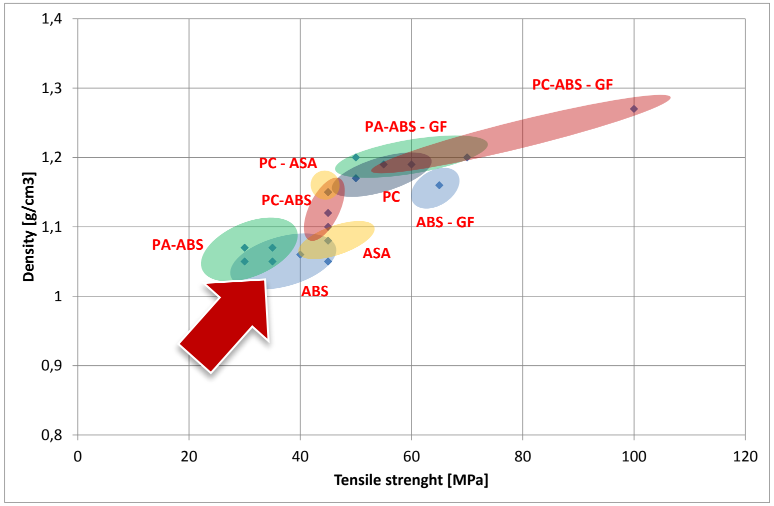


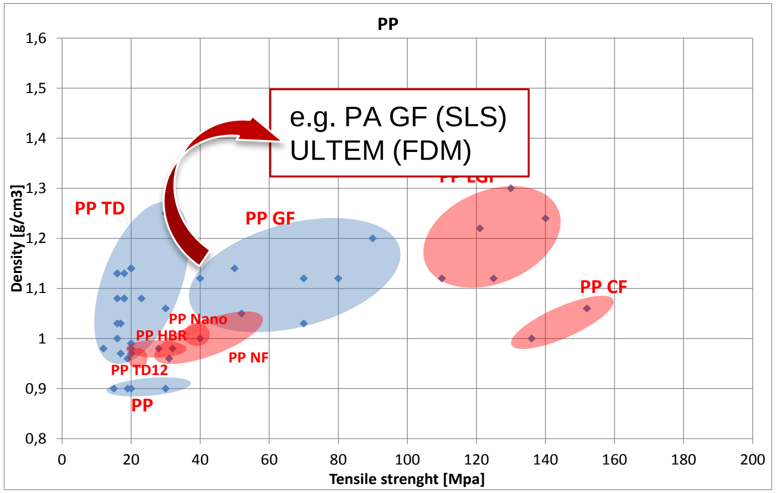


NOW Future Trend

AM Polymers development strategies

1 Develpment of same materials in use



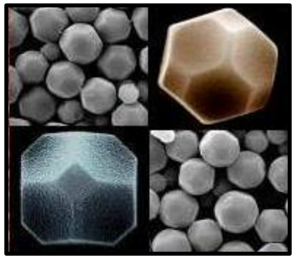


2 Development of more performing materials instead of today used

3 Development of functionalized fillers for specific requirements and multifunctionality

Natural fibers

Nano fillers



Fibers and mineral fillers

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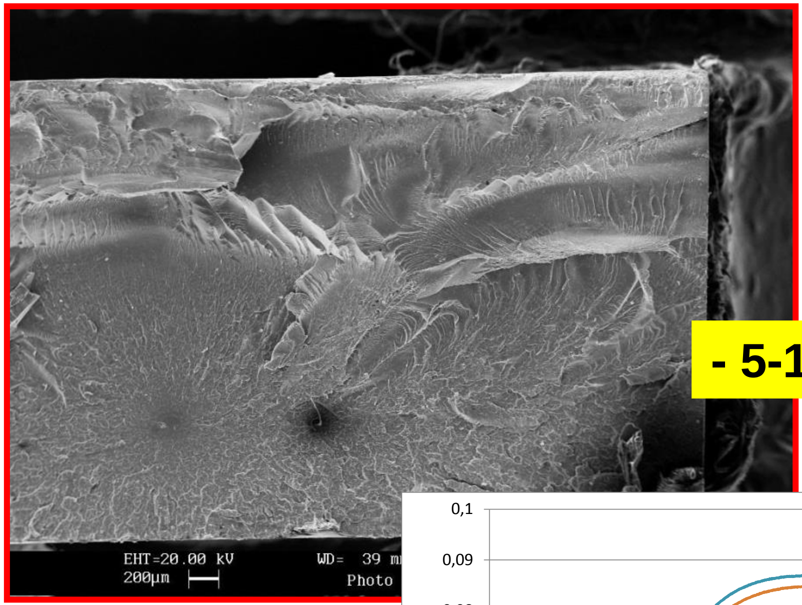
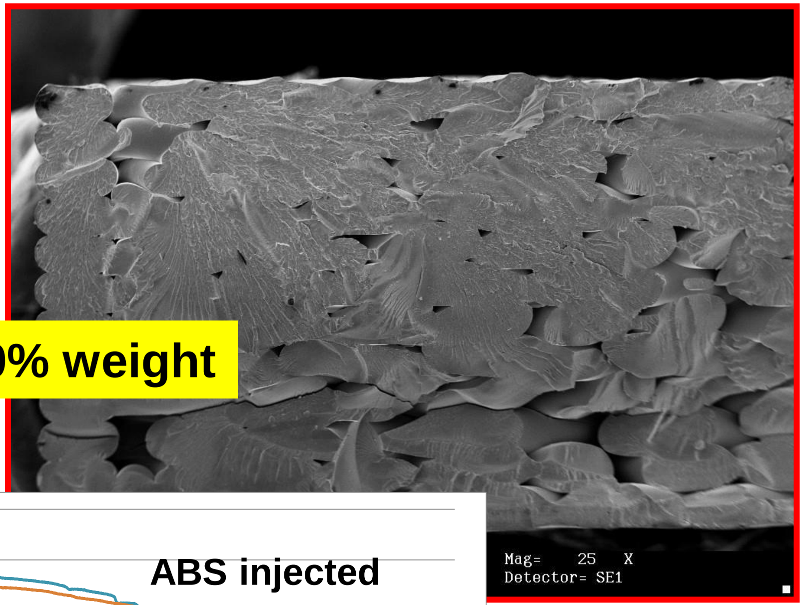
Strategy 1 – Develpment of same materials in use

Issues to be managed by robust design: porosity

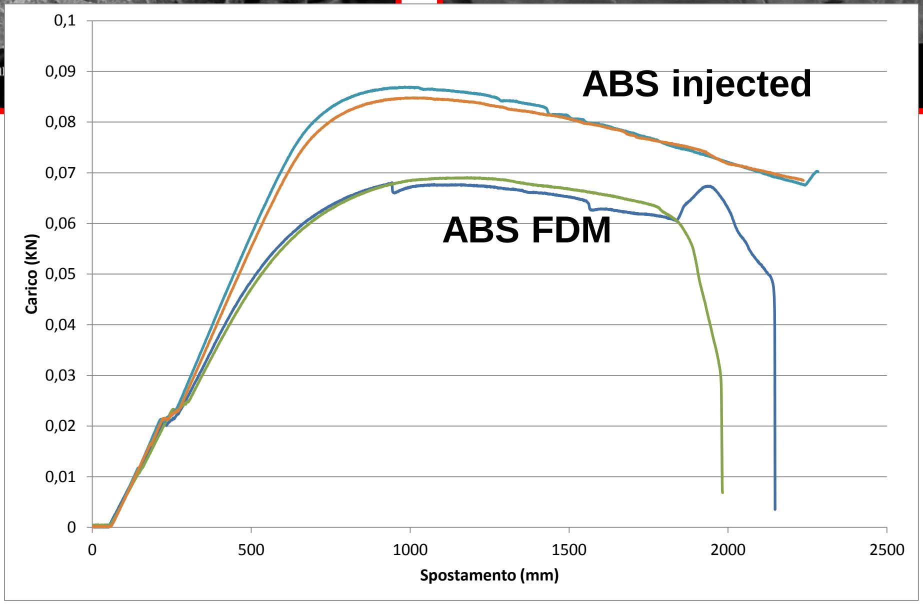
Injection moulding of AM material (ABS)



FDM deposition (ABS)



- 5-10% weight

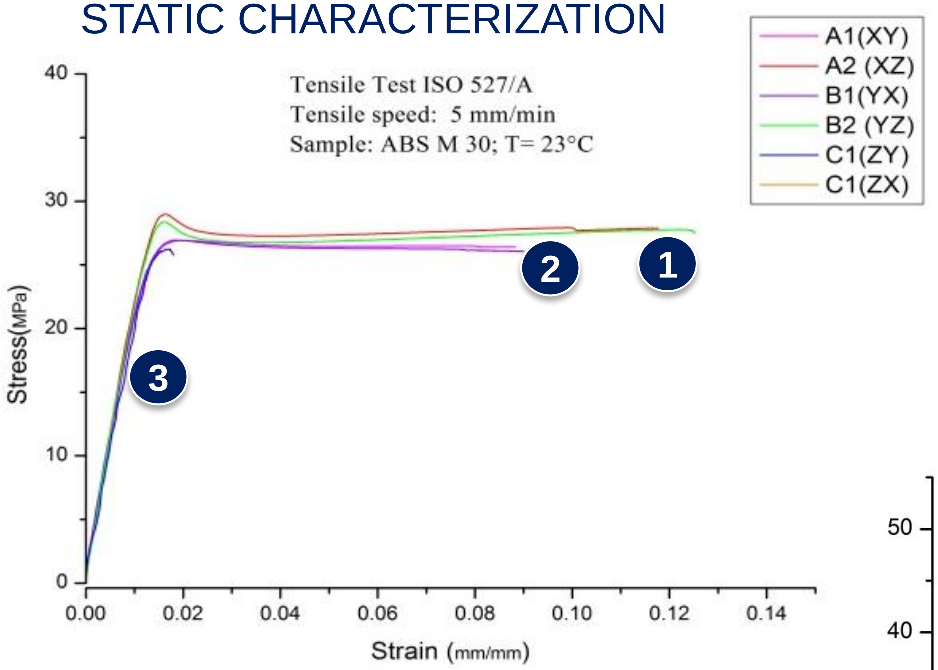


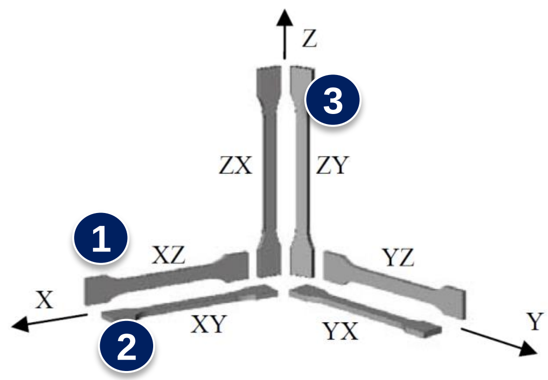
<u>Flexural curves</u>

Strategy 1 – Develpment of same materials in use

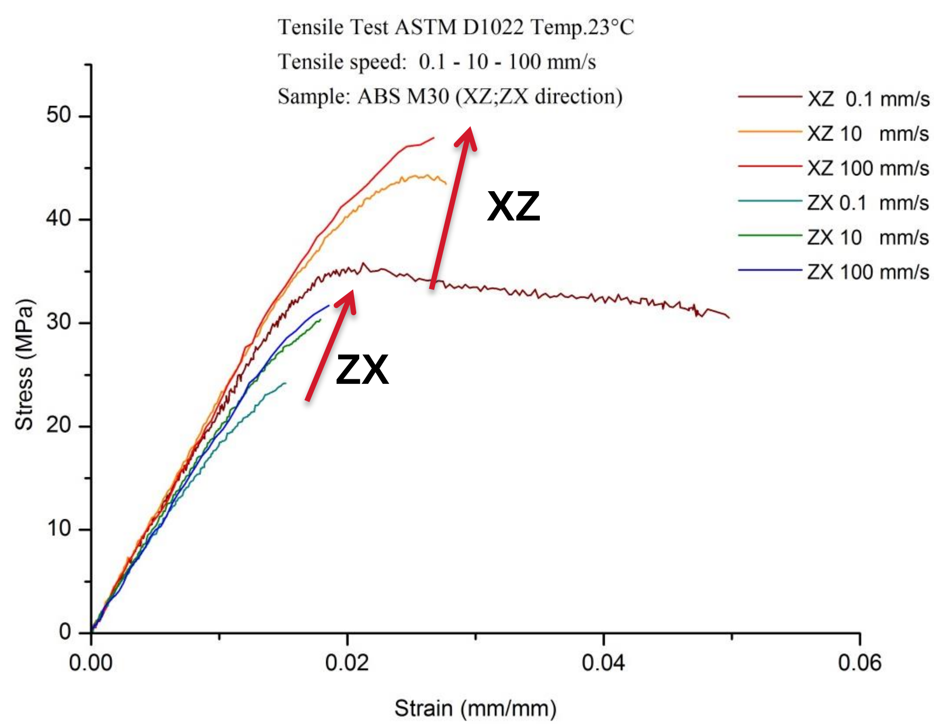
Issues to be managed by robust design: mechanical properties vs directions

STATIC CHARACTERIZATION





HIGH SPEED CHARACTERIZATION



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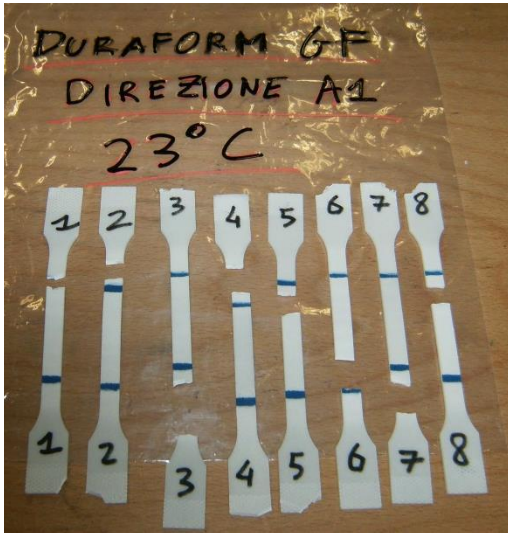
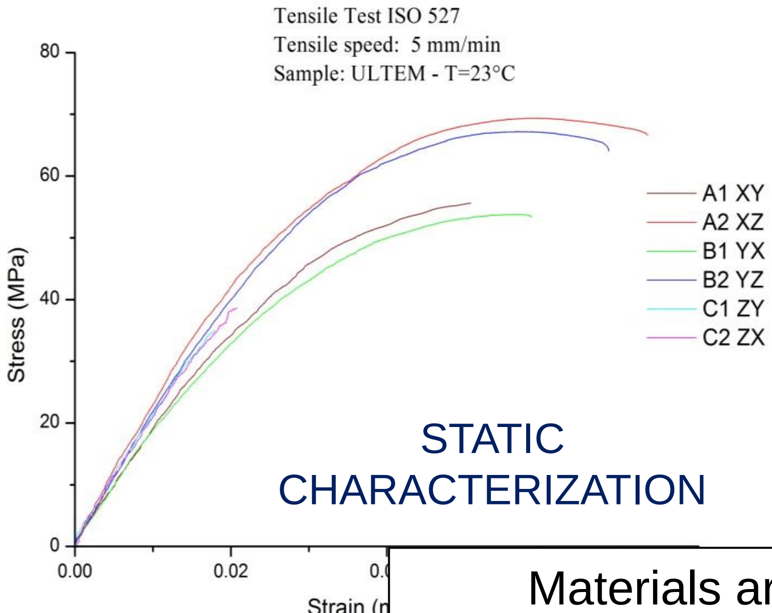
Strategy 2 – Use of more perfoming materials

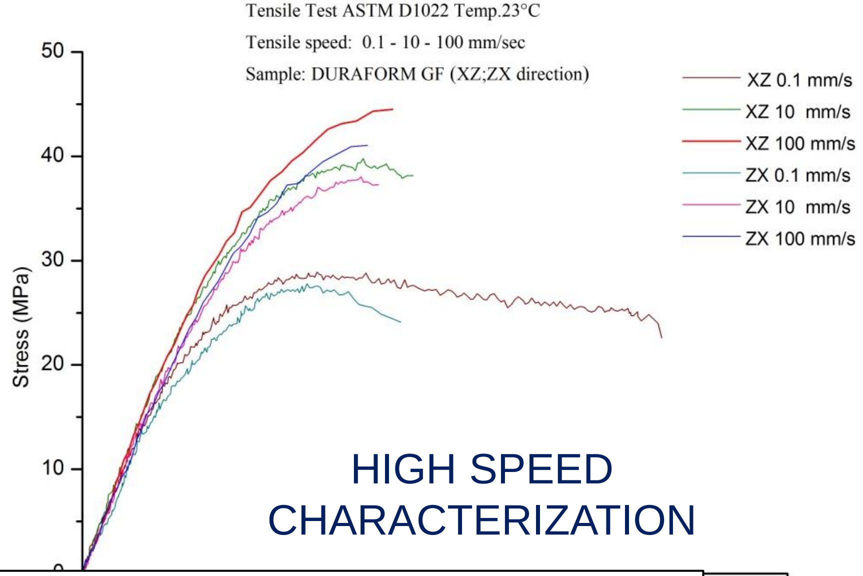
Material: ULTEM
FDM techcnology



Material: PA12 GF
SLS techcnology



STATIC CHARACTERIZATION



HIGH SPEED CHARACTERIZATION

Materials are today available on the market
(e.g. PA6 GF, PA12CF, PEEK for both FDM and SLS)

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Strategy 3 – Multifunctional fillers

Improve thermal properties for current applications

PA6+ZD

Layered (sheet-like) silicate (thickness 1nm, diameter 50-500nm)
Reduced percentage of charge (2-10%)

GRUPPO MAIP

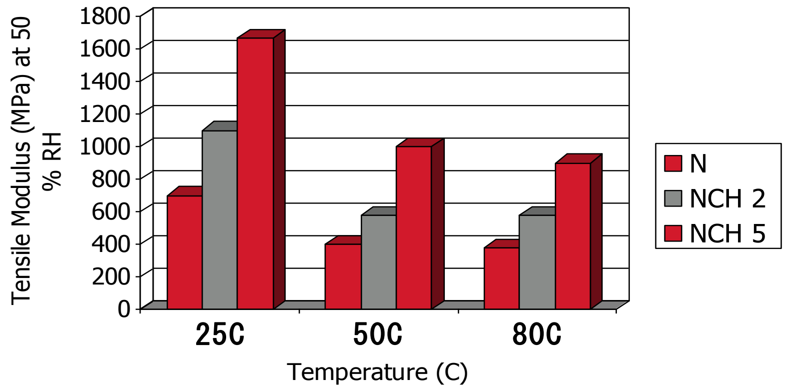
1. **Increase of thermal and mechanical properties**
2. **Better dimensional stability**
3. **Better rheological properties**
4. **Excellent surface aesthetic aspect**
5. **Better barrier properties**
6. **Reduction of weight**

ENGINE COVER
Maserati

Strategy 3 – Multifunctional fillers

Mechanical and thermal properties

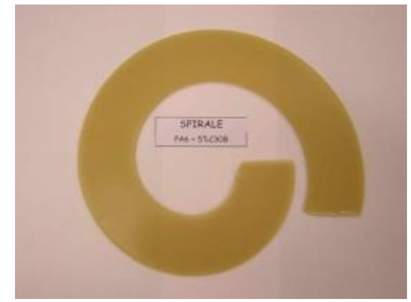
Tensile Modulus (NCH, T)



Rehological properties (process)

- ✓ **Homogeneous fillers dispersion**
- ✓ **Flow stroke**

PA6+30%GF	**37 mm**
PA6+5%C30B	**46 mm**



Dimensional stability

PA 6,6 30 GF: warpage 35mm

NANOCOMPOSITE PA : warpage 1mm

WEIGHT REDUCTION

PA-GF **1.36 - 1.55 g/cm3**

PA6+ZD **1.15 g/cm3**

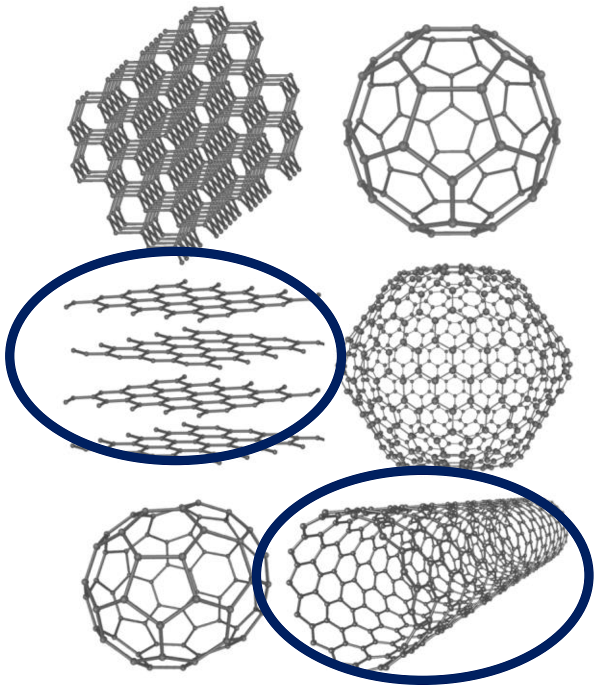
- **up to 25% weight reduction** (PA6+40% mineral charge with similar properties PA 6 +ZD)
- Good aesthetic features (no painting)

Strategy 3 – Multifunctional fillers

Smart polymeric materials for new functionalities

Electrically conductive fillers

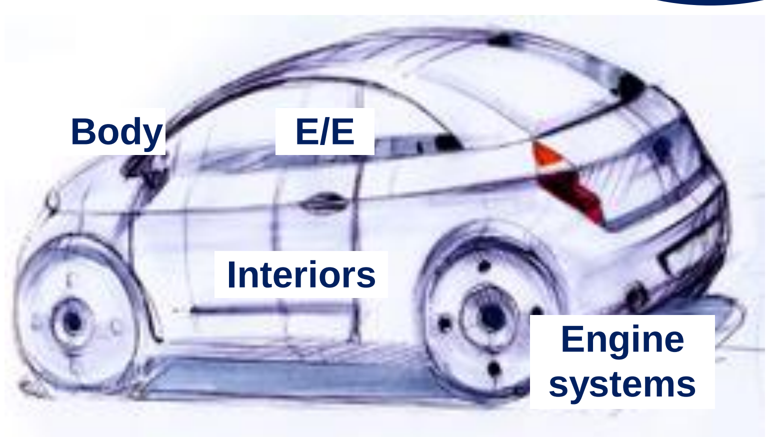
GRAPHENE-LIKE STRUCTURES



NANOTUBES

Full polymer devices integrating

- Wirings
- Electrical circuits
- Sensors
- Switches

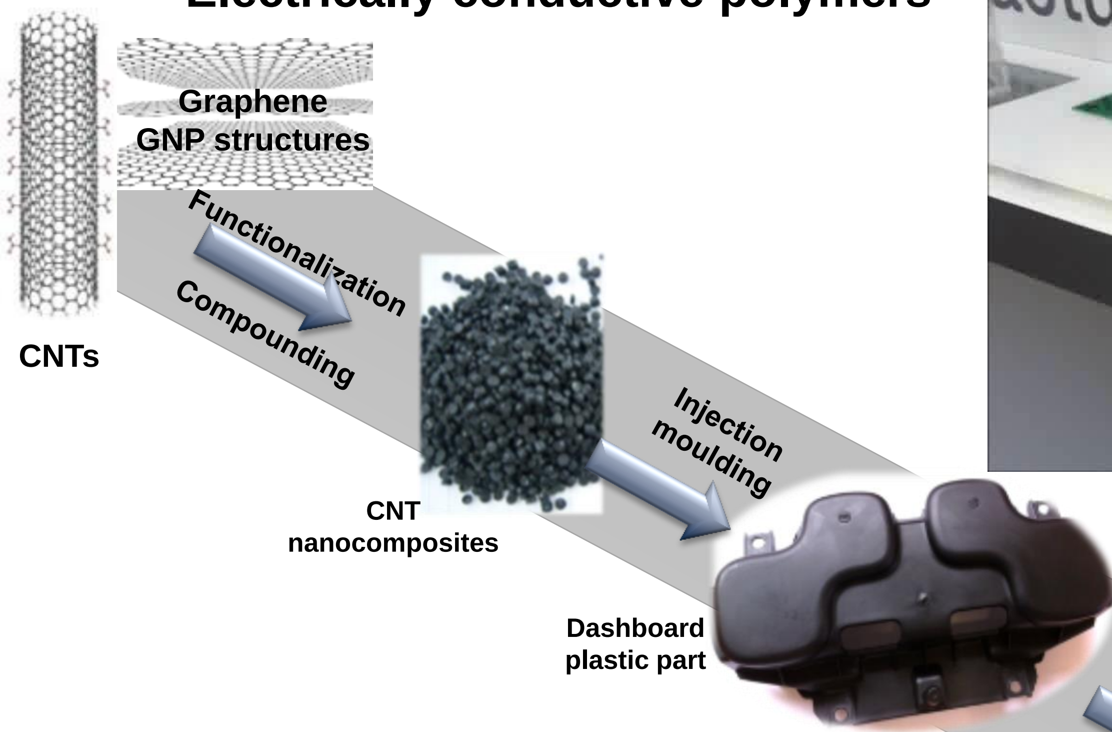


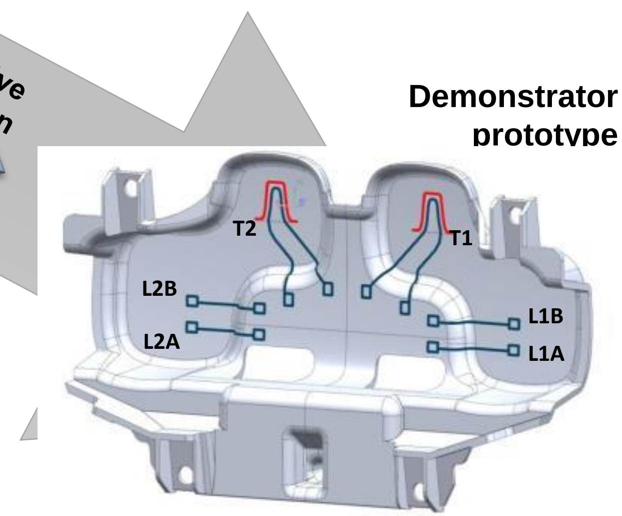
MAIN BENEFITS

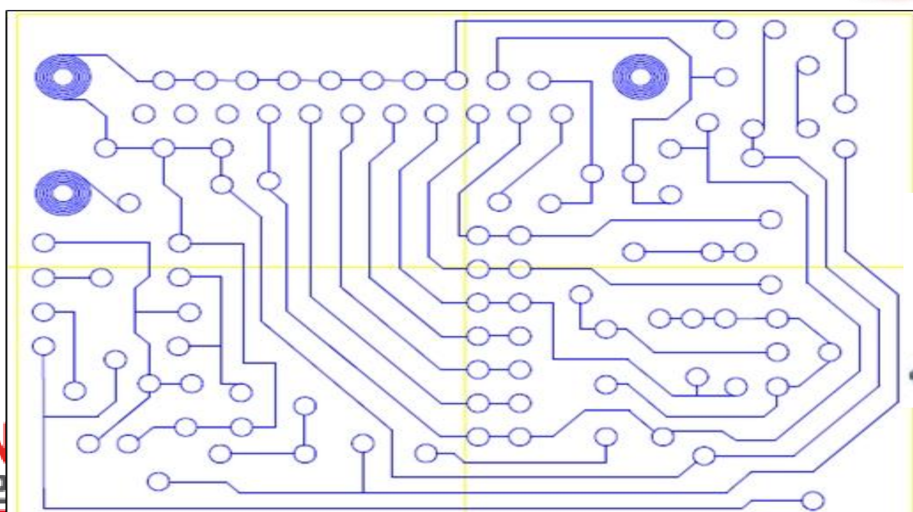
- ✓ Metal wiring substitution
- ✓ Weight and cost reduction
- ✓ Assembling simplification
- ✓ Easy recycling at ELV
- ✓ Improved perceived quality

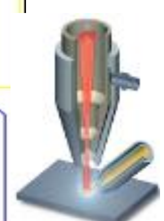
Strategy 3 – Multifunctional fillers

Electrically conductive polymers









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Conclusions

- Different classes of metallic and polymeric materials with several variations are today used in our cars and AM technologies must find proper way to be applied.
- AM strenghts are represented by:
  - Design flexibility (any shape)
  - Increased range of materials with promising properties; different strategies can be followed: substitution 1:1 or use of more performing materials
  - Compatible with developments of multifunctional fillers to same and/or improved properties
- AM needs from materials perspectives:
  - Set up of robust methodologies to fully evaluate SoA materials
  - Proper re-design of components to pass all standards managing issues related to lower mechanical performances respect to injected parts and strong influence of direction deposition
  - Process parameters optimization
- Establishment of a stronger value chain working with materials providers and processes developers as today with well established industrial processes

Thanks for your attention!