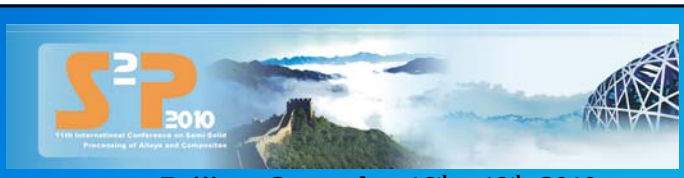

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Development of industrial components by improved rheocasting system

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Outline

- Short introduction, Objectives
- Experimental procedure
- Some results
- Final remarks / Future work

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Background

Basic idea:

Al-based alloys: an attractive option to ferrous alloys to produce components for automotive and aeronautical application

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How to obtain it?

a. Traditional techniques: Forging, HPDC, etc.
b. Relatively new technology: Semi-solid processes

Why?

To create high performance components in competitive way: combines the forming capabilities of die casting with the mechanical properties of forging

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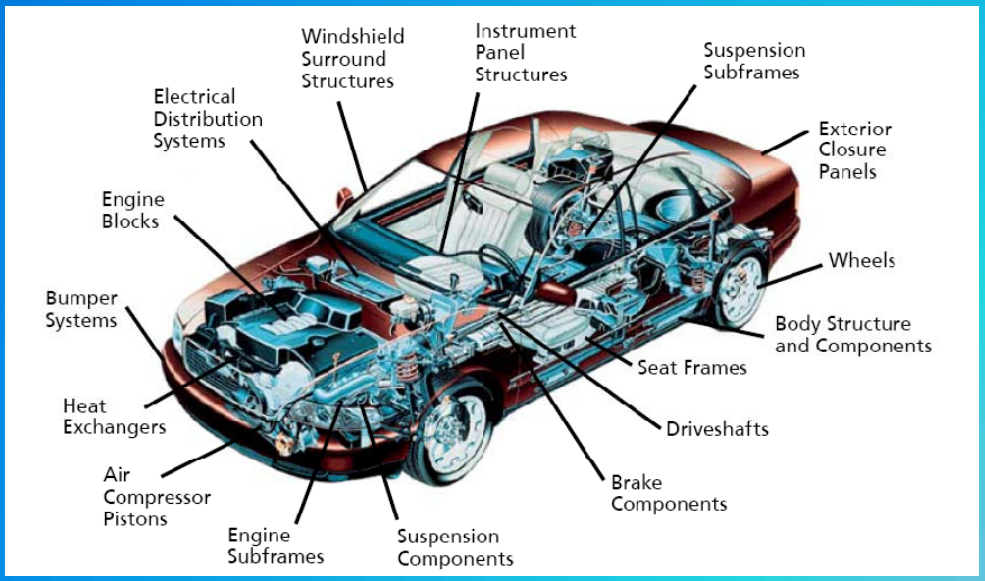
Use of Al-based alloys



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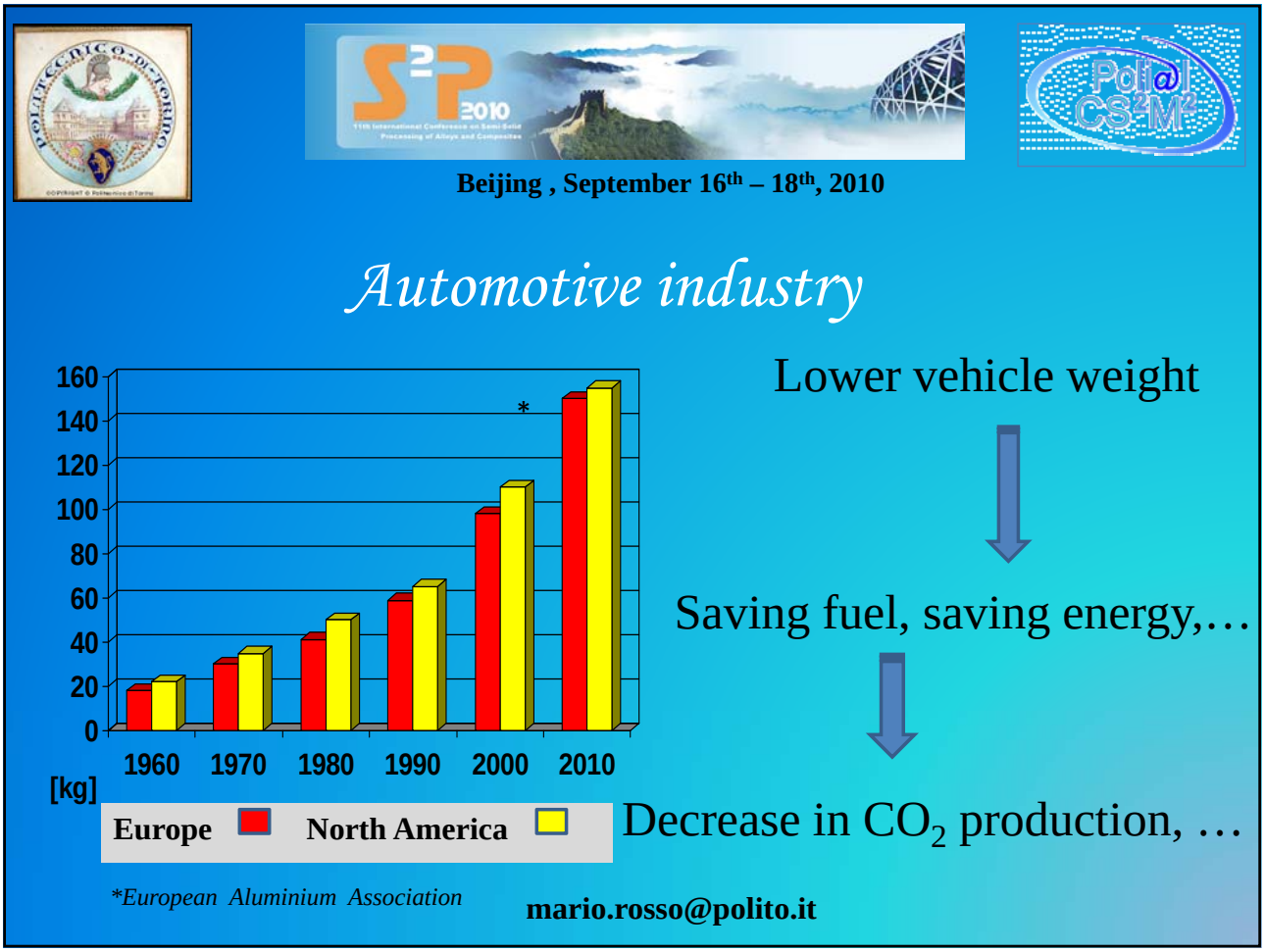
S2P 2010
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Automotive industry
160
140
120
100
80
60
40
20
0
[kg]
*
1960
1970
1980
1990
2000
2010
Europe
North America
Lower vehicle weight
Saving fuel, saving energy,…
Decrease in CO_2 production, …
*European Aluminium Association
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Semi-solid forming

drastically reduces the imperfections in the conventional Al casting or forging process

- Squeeze casting
- Thixoforming
- **Rheocasting**

to obtain

Al component:

- with good surface quality
- high dimensional accuracy
- high strength and ductility
- reliability

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Objectives

Study of some components in A356 alloy following T5 or T6 heat treatment produced by improved Rheocasting system

A356 alloy

Si	Mg	Cu	Fe	Mn	Zn	Ti	Ni	Other
6,5 ÷ 7,5	0,2 ÷ 0,40	0,10	0,7	0,4	0,10	0,2	0,10	0,10

- T5 heat treatment: water quenching , ageing at 165° C , 6 h;
- T6 heat treatment: 520° C, 6 h , ageing at 165° C , 6 h.

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Component: f*lange for truss* obtained by improved rheocasting process manufactured at ATS company employing a TCS system with vertical hydraulic press *Rotorone 400 tons model*.

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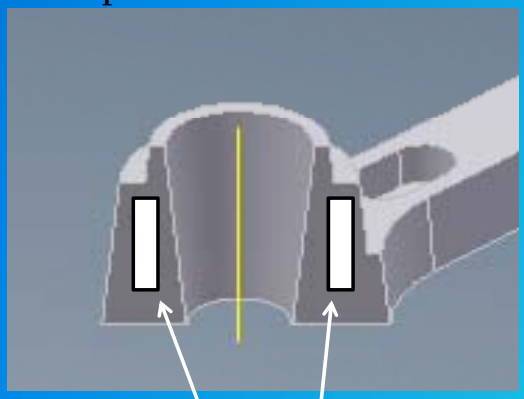

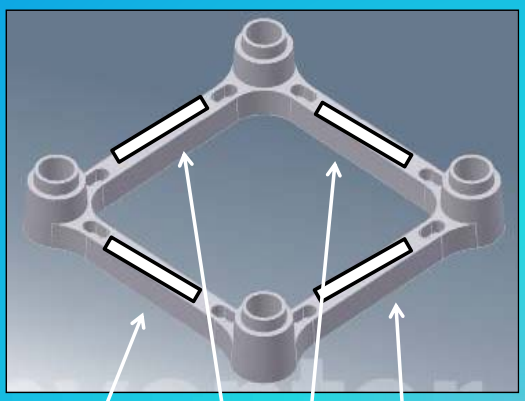

Samples for morphological analysis

Samples for mechanical tests

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The ATS rheocasting process

The semi-solid forming system at ATS is the fruit of a study into existing rheocasting processes, such as UBE-NRC, SLC, SSR.
The most important and advantageous aspects for the potential customers in terms of quality and cost have been acquired for each one of these technologies.

The main characteristics are:

- Use of casting alloys and re-utilization of the machining scrap on-site
- Refining of the grain
- Control temperature of the bath, injection, and mould
- Cooling of the metal to obtain globular structure
- Filling of the mould with speed adequate to the solid
- fraction obtained
- Use of primary and secondary alloys
- Possibility to use extrusion alloys (7075)
- Possibility to insert MMCs

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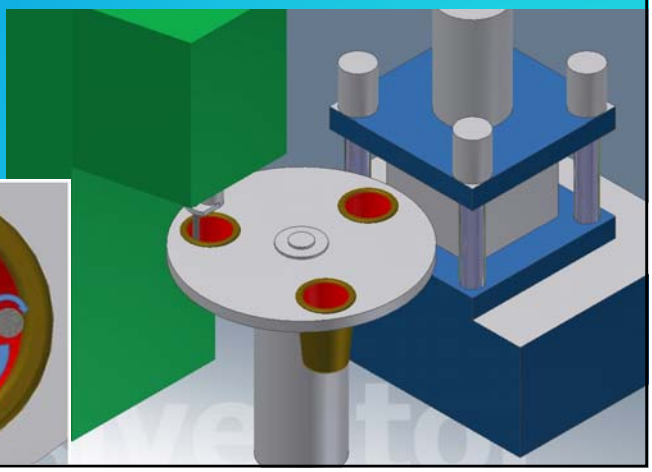
ATS Improved rheocasting process

Under the inferior level of the press a carousel with suitable containers set up at 120° turns to 3 successive working positions:

- in the first one there is the liquid which will be stirred to slurry;
- in the second one the slurry is injected, then there is the evacuation of the biscuit;
- the third one is lubricated and waiting from the ladle new quantity of liquid.



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- the press has an injection piston of 180 mm diameter;
- the closure power: 400 t;
- injection power: 320 t.

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The two upper and lower half dies are heat controlled by oleodynamic pannels control:

-when the requested injection temperature is reached (577°C ÷590°C), the piston pushes the slurry very slowly through the ingate until the filling of the cavity is full;

-after a very short time to maintain the pressure so that the cycle may finished, the piston comes down carrying the biscuit and by consequence cutting off the ingate pieces.

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The press opens and the upper part goes up allowing coming out of the piece with the ejector help;

The part is immediately quenched into the water when T5 heat treatment is requested.

The cycle is ready to continue after the die lubrication.

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Experimental procedure

1.-Radiography observation;

2.-Morphological and compositional analysis: OM, SEM and EDS;

3.-Evolution of the mechanical properties:
microhardness, three point bending stress, impact test;

4.-Fracture surface analysis: SEM.

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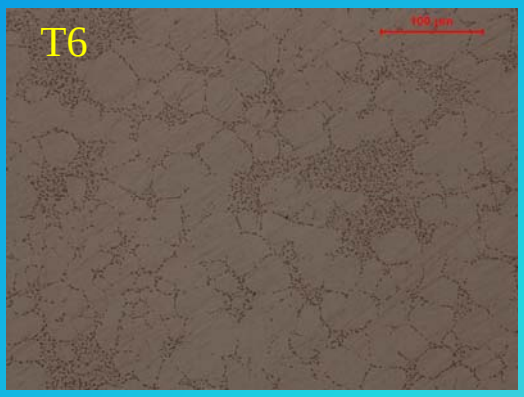
Morphological and compositional analysis



1. Non-dendritic structure, even if the grains are not fully globular;
2. No entrapped gas porosity was observed;
3. T5 treated samples : higher evidence of entrapped eutectic and liquid segregation can be observed than in T6 treated samples.

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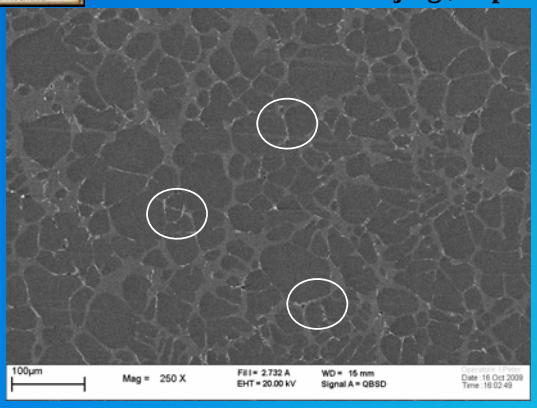
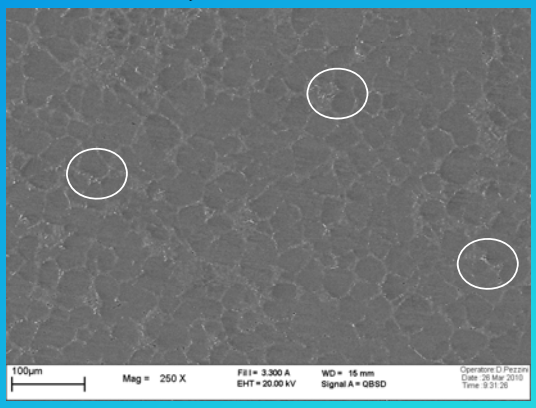
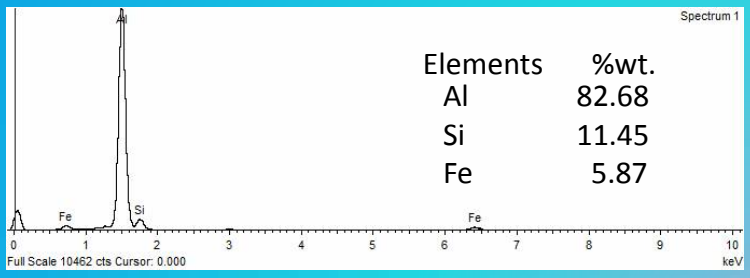




Presence of
Fe-rich intermetallic phases



Elements	%wt.
Al	82.68
Si	11.45
Fe	5.87

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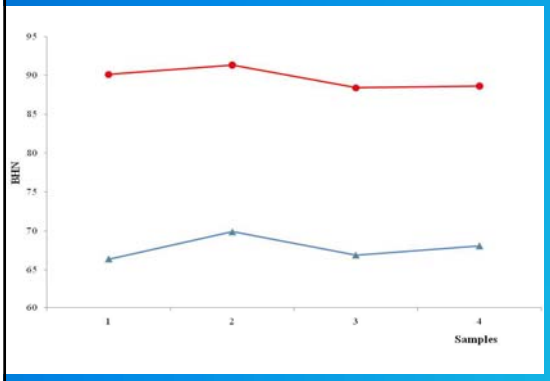
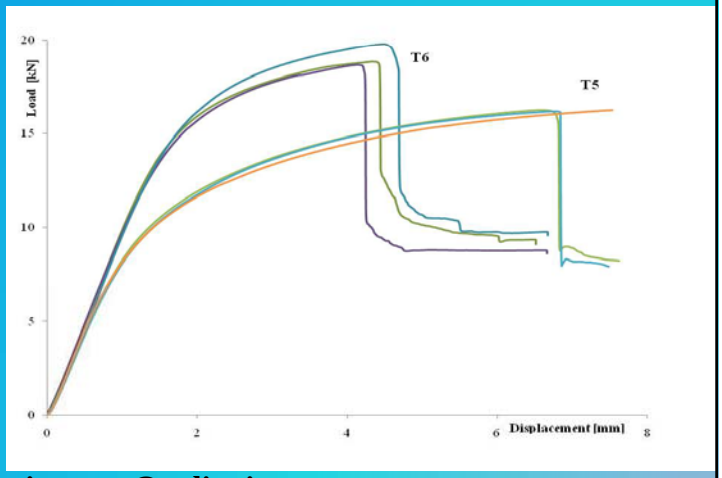
Mechanical properties

Brinnel hardness test



Three point bending test



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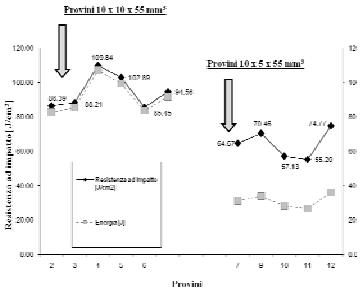
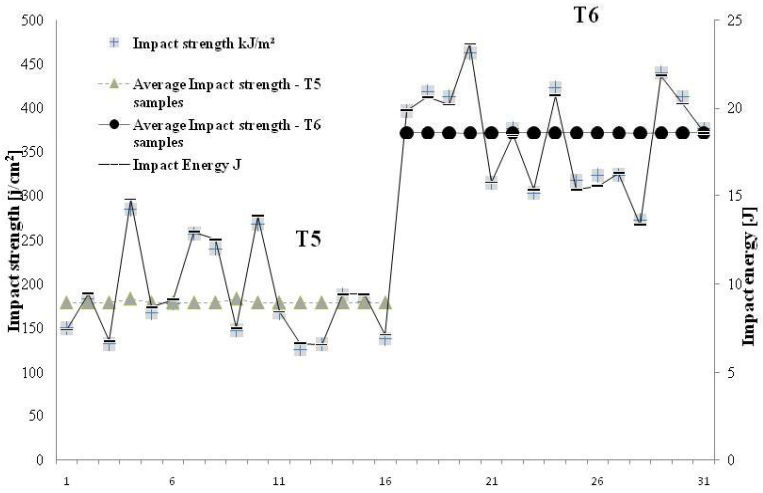
Impact test

Non Standard Specimens, the only possible
10 x 5 x 55 mm

Better results expected from Standard samples
10 x 10 x 55 mm





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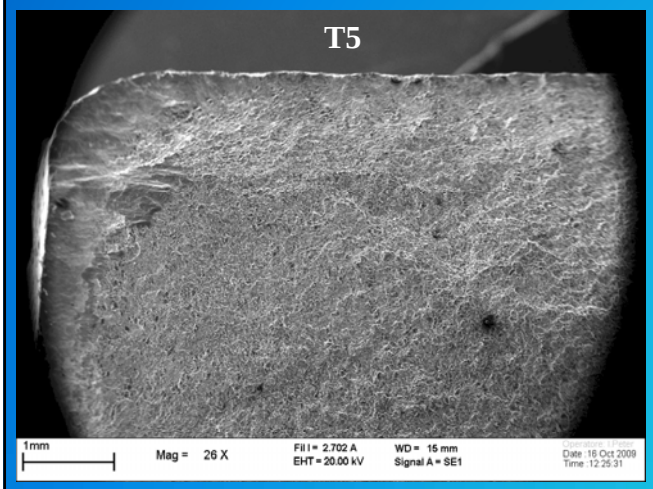
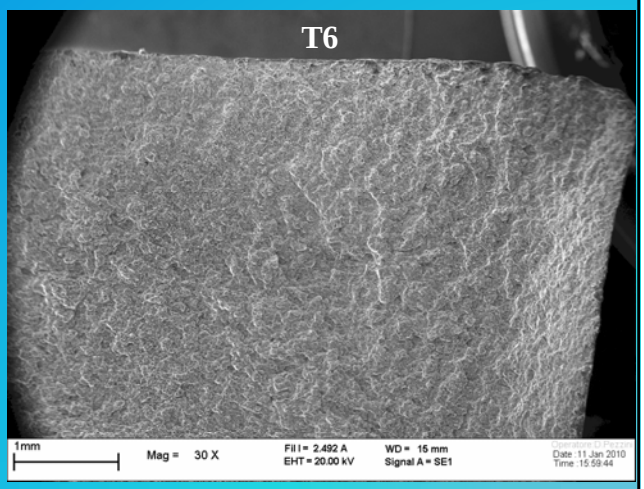
Fracture surface





No evidence of porosity, gas entrapment, inclusions or other large defect which can be directly correlated to the alloys failure

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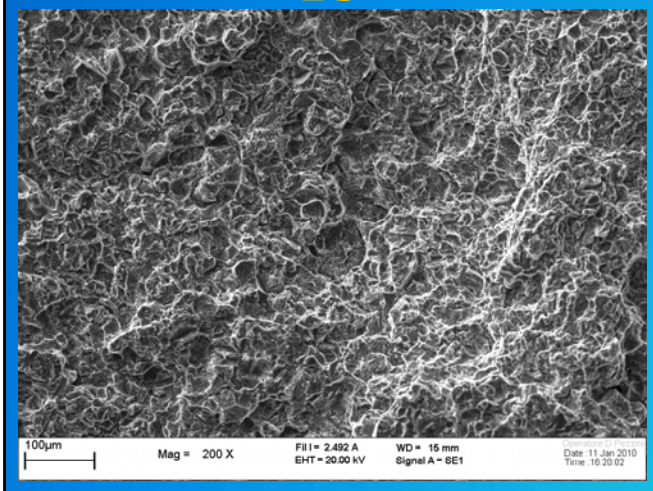
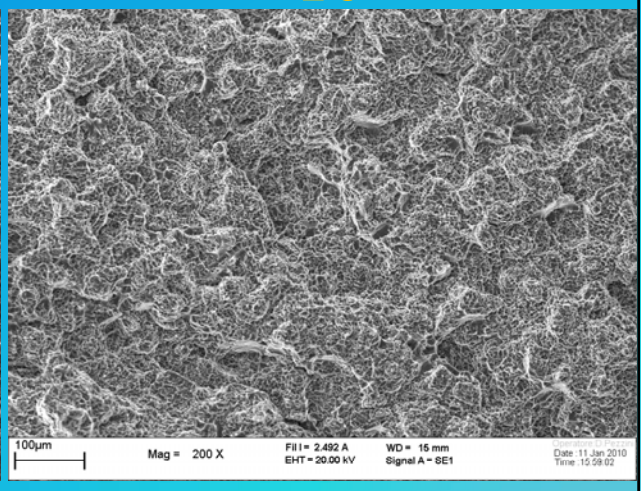
T5



T6



T5: Ductile fracture is predominant
T6: Increased tendency of dimples formation

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Conclusions

- An analysis of an improved rheocasting process suitable for the manufacturing of high performance industrial components.
- Such a process leads obtaining alloys in a semisolid state directly from the liquid state, by controlled cooling of the molten alloys.
- The microstructures obtained are fine and more homogeneous compared to other components produced by traditional techniques.
- The achieved results shown quite high level of mechanical strength for both series of components, even if some further process improvements are running.

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Further developments

Optimization of the process
Manufacturing of parts for automotive industry, as well as for other applications

Improvements of mechanical tests, mainly toward:

- Tensile properties
- Impact toughness on standard Charpy samples
- Axial and rotate bending fatigue strength

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Thank you for your kind attention

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