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«MECHANICAL PROPERTIES OPTIMIZATION OF AS-CAST AUSFERRITIC DUCTILE IRON AS A FUNCTION OF SECTION SIZE AND HOLDING TIME»

U. De la Torre, R. González-Martínez and S. Méndez

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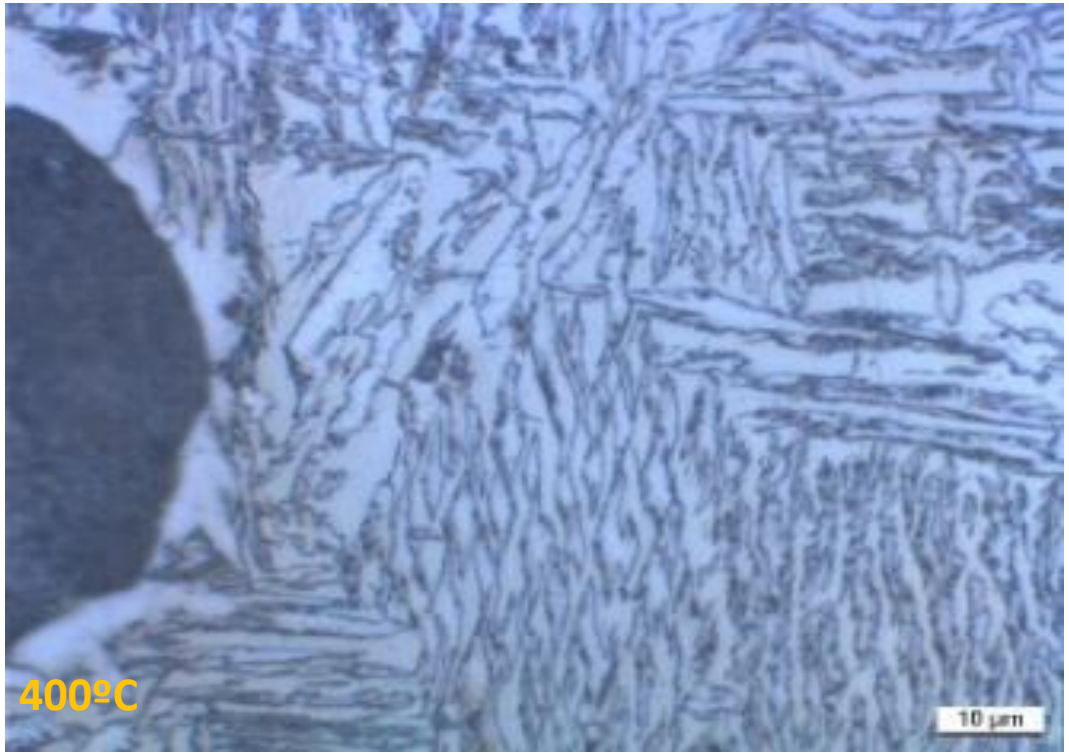

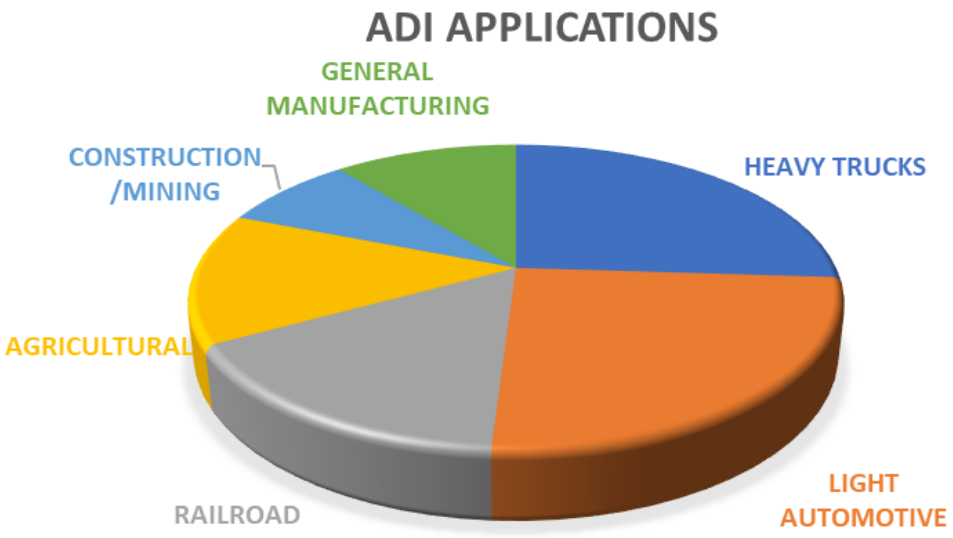

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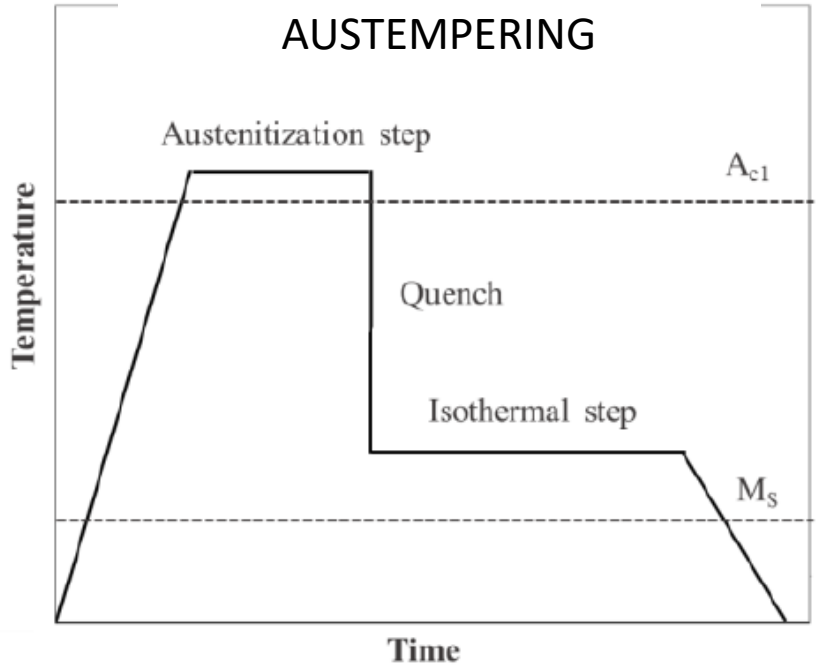
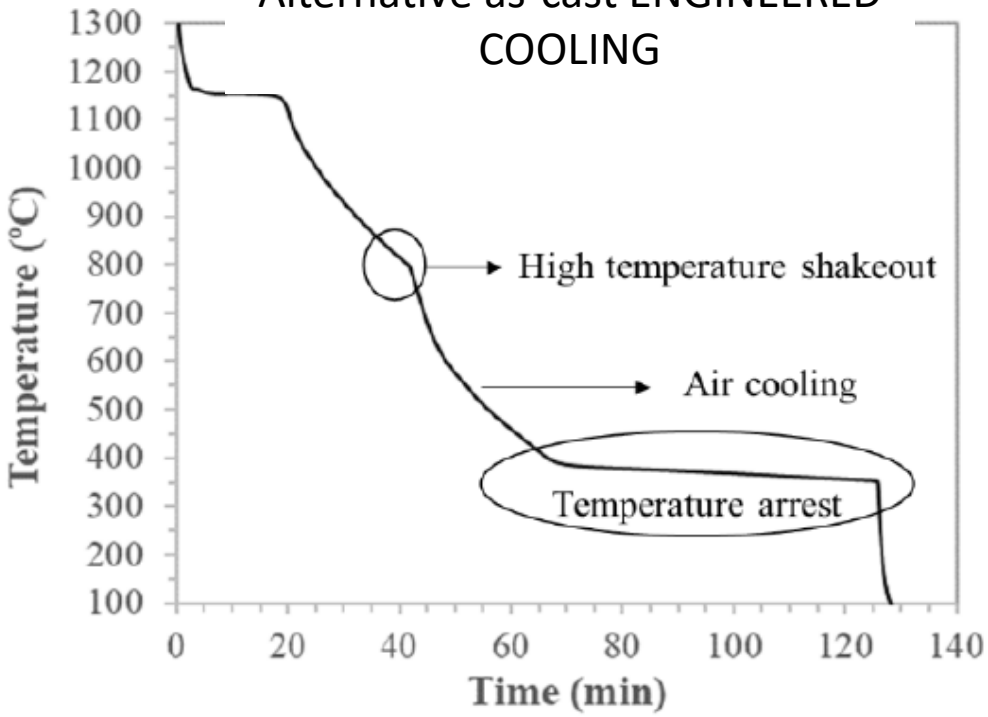
Conventional heat treatment
AUSTEMPERING



Alternative as-cast ENGINEERED COOLING



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PRELIMINARY WORKS

U. de la Torre, D.M. Stefanescu, D. Hartmann, R. Suárez, "As-cast ausferritic ductile iron", Keith Millis symposium proceedings, Nashville, American Foundry Society, October 2013, P. 233-243.

S. Méndez, U. de la Torre, R. Suárez, P. Larrañaga and D.M. Stefanescu, "Processing thickness window for as-cast ausferritic castings", AFS proceedings 2015, Columbus, April 2015, American Foundry Society, 2015, P. 219-226.

S. Méndez, U. de la Torre, R. González-Martínez, R. Suárez, "Advanced properties of ausferritic ductile iron obtained in as-cast conditions", International Journal of Metalcasting, Vol. 11, 2017, P. 116-122.

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PRELIMINARY WORKS – MAIN RESULTS

1. Acting on the chemical composition and cooling process, no subsequent heat treatment is needed to obtain an ausferritic microestructure. It can be obtained in as-cast conditions

2. A model was developped to define the optimal chemical composition and the two procesing temperatures for diferente sections (shake out and isothermal transformation)

3. The material obtained by means of engineered cooling met the requirements of conventional ADI in terms of fatigue, bending capacity at room and at low temperature and in terms of corrosion behavior in NaCl

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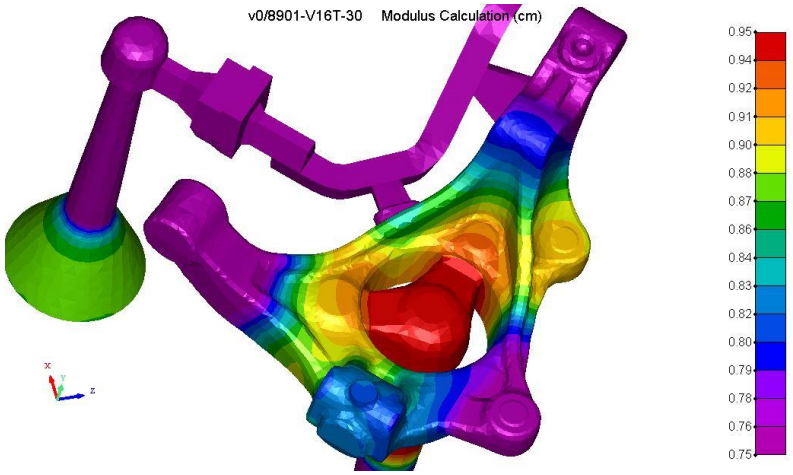
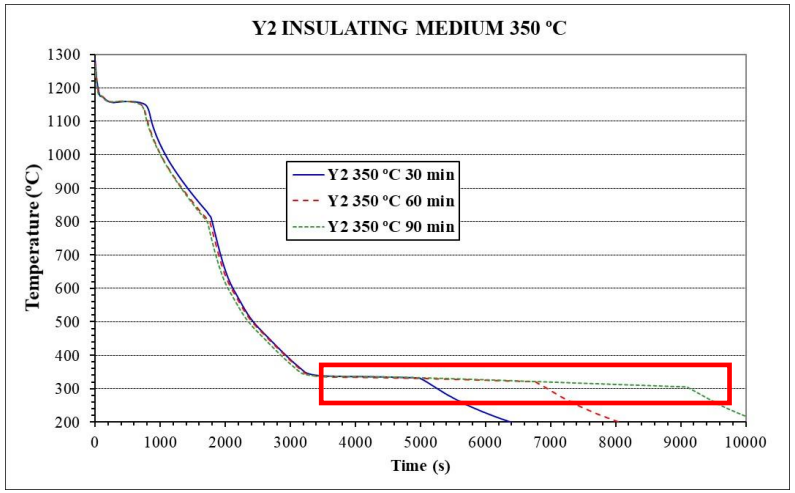
WHAT ASPECTS REMAIN TO BE VERIFIED IN ORDER TO UNDERSTAND THE TRANSFORMATION MECHANISM





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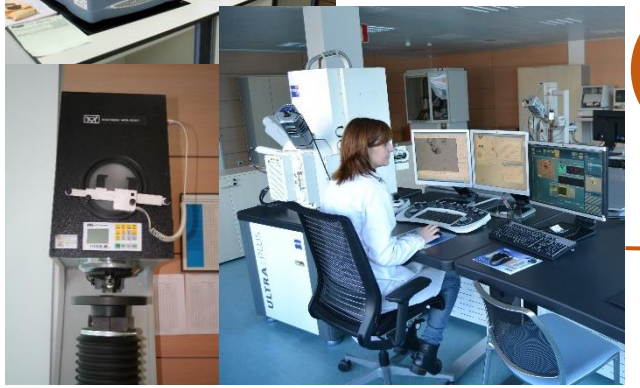
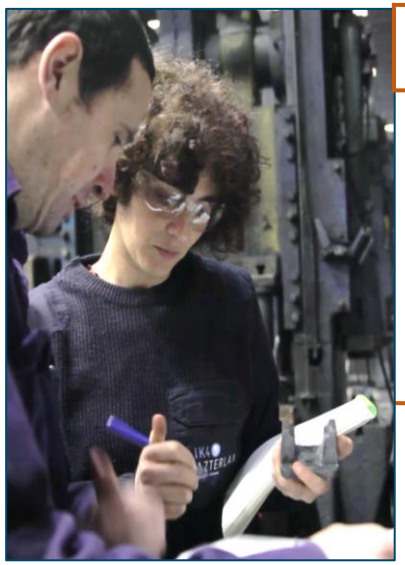
1

EXPERIMENTAL PROCEDURE



RESULTS AND DISCUSSION

2



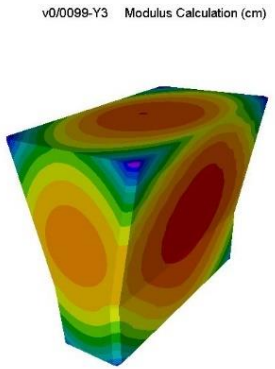
CONCLUSIONS

3

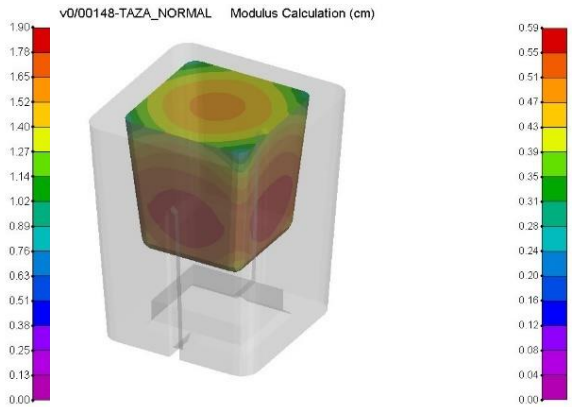
«MECHANICAL PROPERTIES OPTIMIZATION OF AS-CAST AUSFERRITIC DUCTILE IRON AS A FUNCTION OF SECTION SIZE AND HOLDING TIME»

1 EXPERIMENTAL PROCEDURE

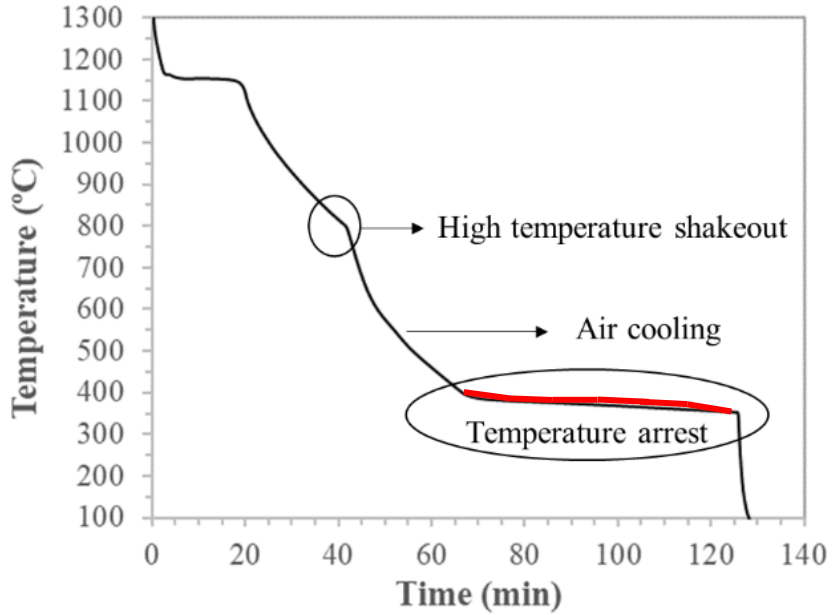
C	Si	Ni	Mo	Mn	Cu	Mg	S
3,54-3,61	2,02-2013	2,90-3,05	0,19-0,20	0,17-021	<0,05	0,045-0,059	0,005-0,010



Keel Block Y3 (EN 1563)



Thermal Analysis cups



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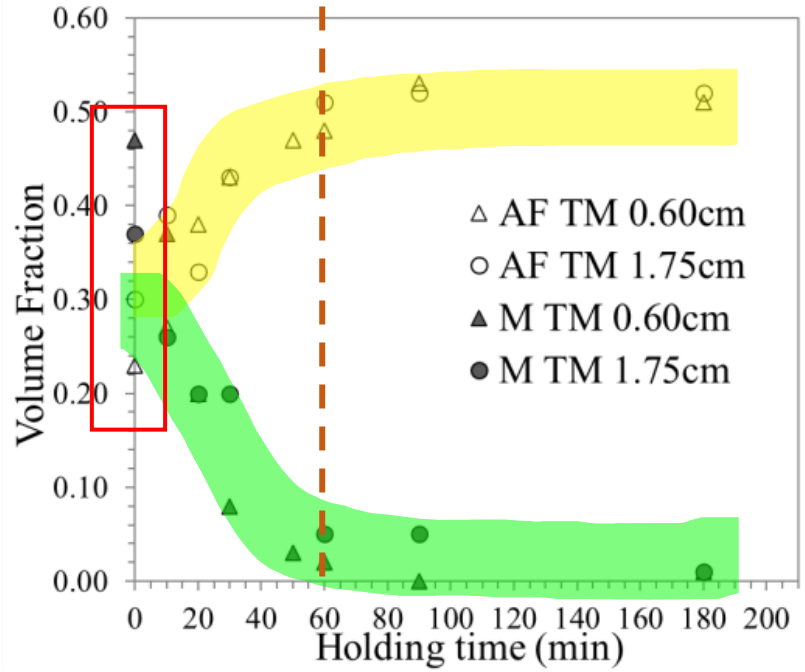
2 RESULTS AND DISCUSSION

EVOLUTION OF THE MICROESTRUCTURE



The ausferrite formation evolves similarly for both thermal moduli

The maximum content of AF is obtained after 60 minutes holding time, which means that the reaction is completed at that time. Then a fully ausferritic microstructure is obtained, made up by acicular ferrite (52 %) and reacted austenite (48 %).

Only at the very early stages of the reaction there are some differences between the studied thermal moduli. This is because the ausferritic reaction starts before the temperature arrest, since the air cooling is not a high enough cooling rate so as to avoid the ausferritic nose till the castings are introduced into the insulating material, as was seen on a former development

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2 RESULTS AND DISCUSSION

EVOLUTION OF THE MICROESTRUCTURE

THE AUSFERRITE TRANSFORMATION IS NOT A DIFFUSIVE PHENOMENON

The TM or the section size is not significantly affecting the evolution of the transformation.

For a diffusive phenomenon, the higher the section size, the longer the time the reaction needs to be completed, because the atoms need to through longer distances. In this case, independent of the section size, the transformation rate is similar. For this reason, it can be considered that the reaction occurs simultaneously on the different parts of the casting,

THE AUSFERRITE TRANSFORMATION IS A DISPLACIVE PHENOMENON

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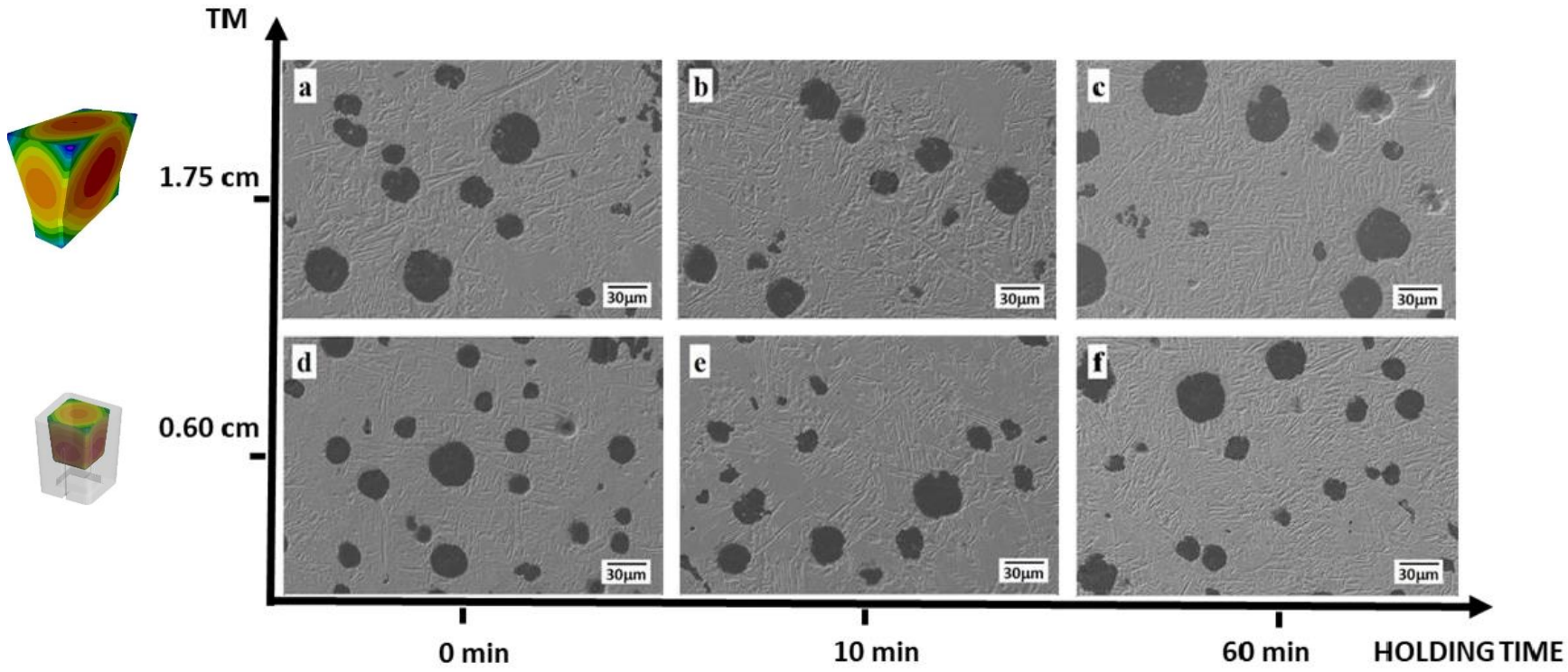

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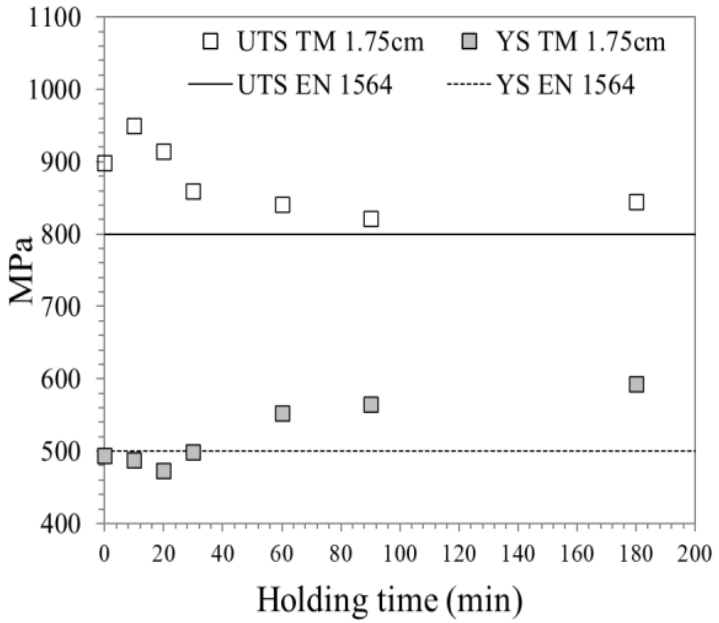
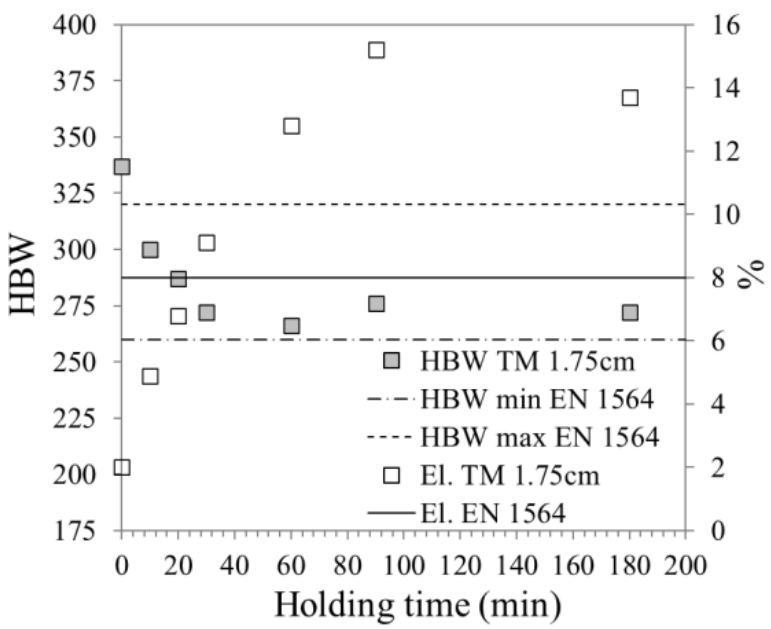
2 RESULTS AND DISCUSSION

EVOLUTION OF THE MECHANICAL PROPERTIES





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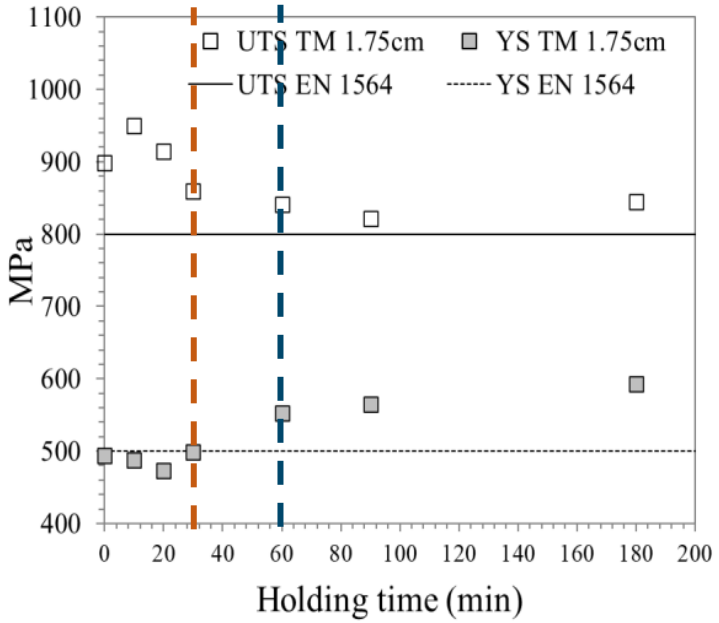
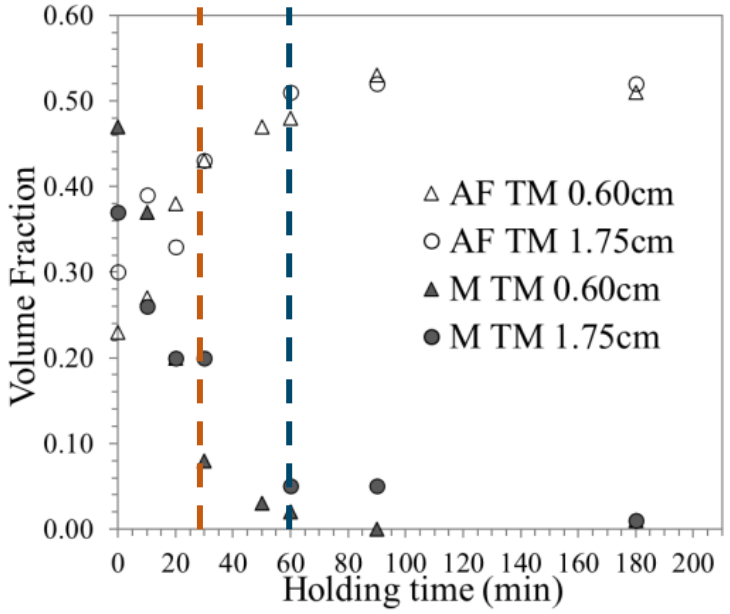
2 RESULTS AND DISCUSSION

MECHANICAL PROPERTIES vs MICROSTRUCTURE





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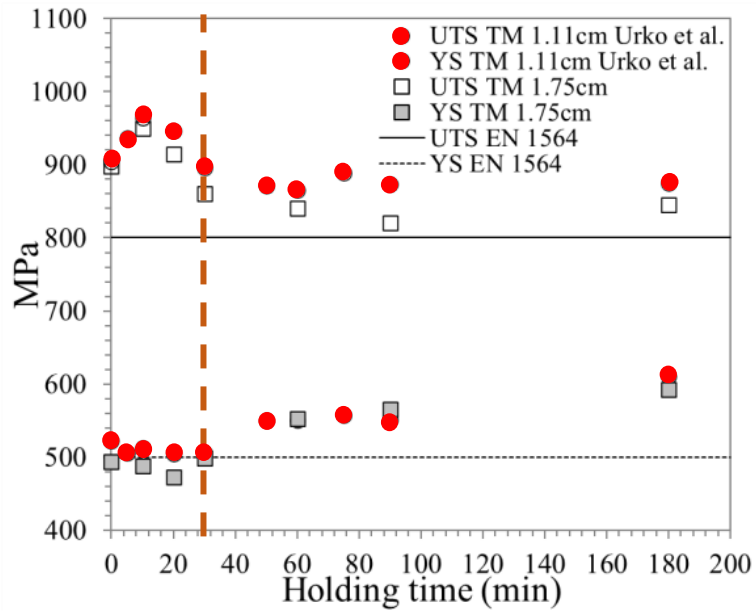
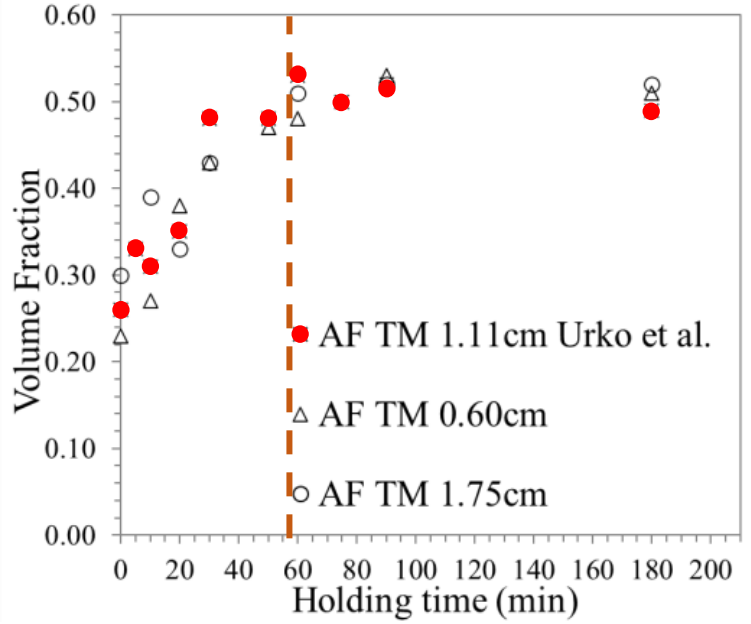
2 RESULTS AND DISCUSSION

DATA FROM LITERATURE





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3 CONCLUSIONS

A complete ausferritic microstructure was obtained by means of an engineered cooling methodology with no extra energy addition to the poured casting.

The microstructure evolution shows that the ausferritic transformation is completed after 60 minutes holding time.

No influence of the section size is shown regarding the microstructure evolution during the temperature arrest. This is in good accordance with a displacive nature of the reaction.

The mechanical properties requirements of the ADI materials are satisfied after 30 minutes holding time. The mechanical properties improve till 60 minutes holding time, in terms of a yield strength and elongation. Afterwards, they remain constant.

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Thank you for your attention

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