MATERIALS

STRESS SCANNING

NEUTRONS FOR SOCIETY

High-strength Aluminium Alloys: investigating stresses for improved casting

THE PROBLEM to solve: residual stress

Direct chill casting is a process where the liquid metal is cooled rapidly, through contact first with an open mould and secondly with cooling water running across its surface. This process allows for very large-section castings of up to one metre thick (figure 1). As the surface of the ingot solidifies before, and more rapidly than, its centre, high thermal stresses appear in the bulk material; this can lead to the formation of cracks. Crack propagation can cause serious safety issues during downstream processing. It is therefore important to find casting processes that reduce this risk.

A step towards THE SOLUTION

Due to the excellent ability of neutrons to penetrate metals, it is possible to measure deformation within a component non-destructively by observing diffraction peaks. A study was conducted to compare two aluminium ingots (fig. 1) produced by direct chill casting but subjected to different cooling processes. The results revealed that cooling process B generated a third less tensile residual stress during casting (fig. 2).

THE RESULT

Neutrons can reveal full tensile stress non-destructively in industrial-scale engineered parts, at lateral resolutions in the millimetre or sub-millimetre range.

(1) Aluminium ingot wrapped in a security net, mounted on the sample stage of the stress scanner.
(2) Computed and measured stress profiles in the longitudinal axis, starting from the surface, for the two ingots: cooling process B shows a **tensile residual stress reduction of about 30%** compared to process A.

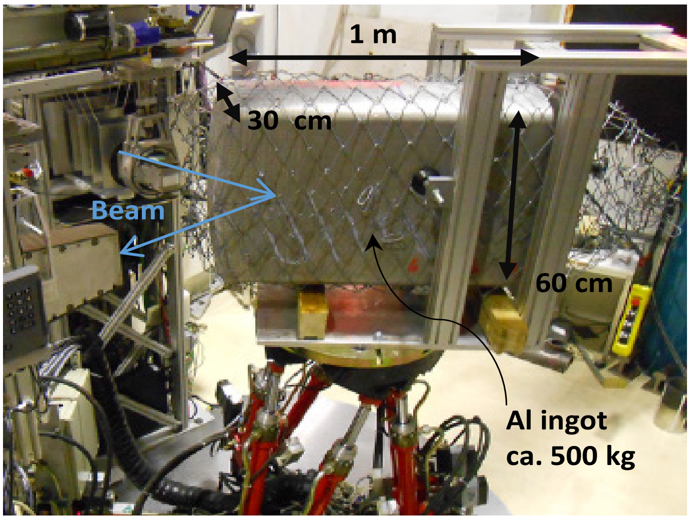


Figure 1

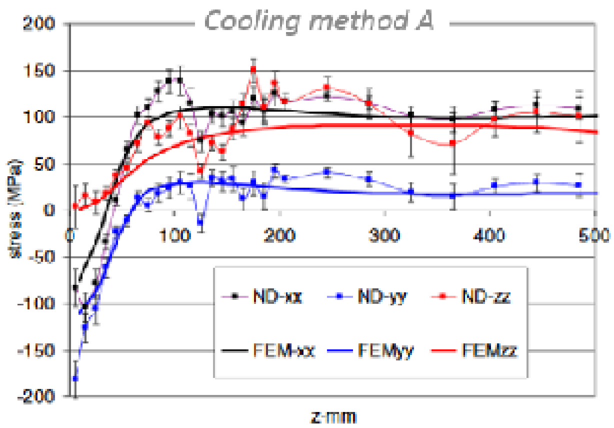
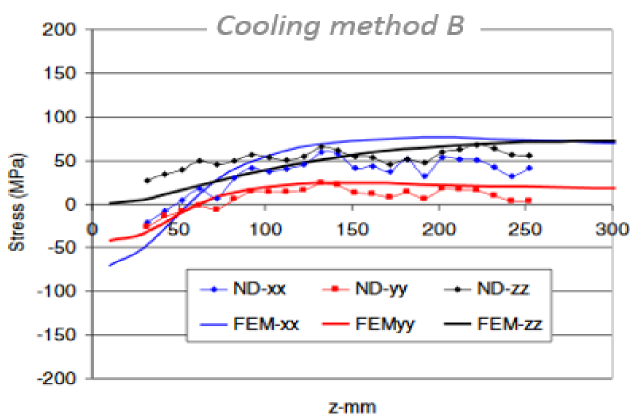


Figure 2

ND: neutron diffraction FEM: finite element modelling.



Original plots with the authorization of Elsiever.

REFERENCE
Drezet et al., Materials Today: Proceedings (2015), T. Pirling in ILL Annual report (2015)

Neutrons for Industry

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Czech Republic, France, Germany, Hungary, Netherlands, United Kingdom.

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