

# Quench sensitivity of cast and wrought aluminium alloy 7055

Shengdan Liu<sup>1,2</sup>, Xinming Zhang<sup>2</sup>, Sam Gao<sup>1</sup>, Barry C. Muddle<sup>1</sup>

<sup>1</sup>ARC Centre of Excellence for Design in Light Metals, Department of Materials Engineering, Monash University, Australia

<sup>2</sup>School of Materials Science and Engineering, Central South University, PR China

## Introduction

High strength precipitation hardening 7055 aluminum alloy is used extensively as a structural material in the aircraft industry. When this alloy is used to produce thick primary structural parts, its quench sensitivity is important since there may be a reduction of mechanical properties induced by a slow quenching rate. In the present study, the quench sensitivity of both Zr-free and Zr-containing 7055 alloys has been investigated by the *End Quench* test.

## Experimental

Alloys 7055 (Al-7.9Zn-2.2Mg-2.1Cu-0.15Zr) are processed according to the scheme shown in Fig. 1. Samples with different compositions, rolling treatments and quenching rates are analyzed.

## Results

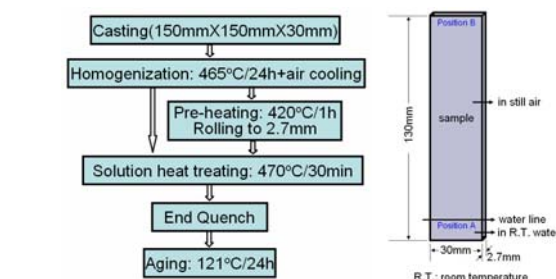
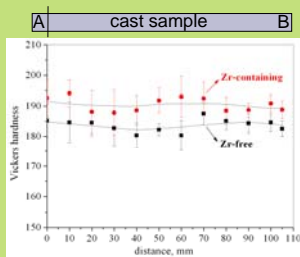
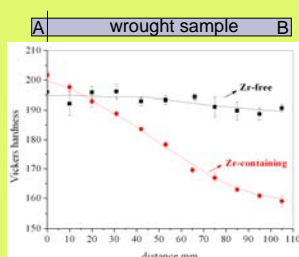


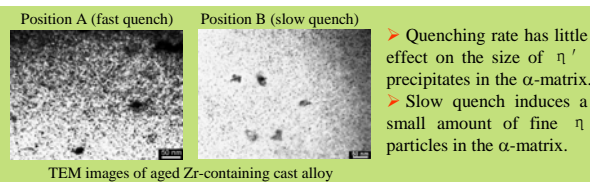
Fig. 1 Experimental procedure and schematic illustration of the *End Quench* test.



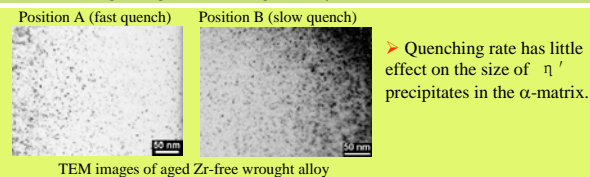
- There is no significant quench sensitivity for both Zr-containing and Zr-free cast alloys.
- The Zr-containing cast alloy has a higher hardness than the Zr-free cast alloy.



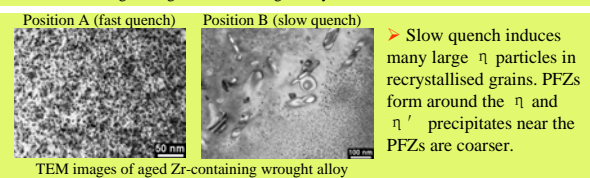
- There is no significant quench sensitivity for the Zr-free wrought alloy. In contrast, there is a significant quench sensitivity for the Zr-containing wrought alloy.



- Quenching rate has little effect on the size of  $\eta'$  precipitates in the  $\alpha$ -matrix.
- Slow quench induces a small amount of fine  $\eta$  particles in the  $\alpha$ -matrix.



- Quenching rate has little effect on the size of  $\eta'$  precipitates in the  $\alpha$ -matrix.



- Slow quench induces many large  $\eta$  particles in recrystallised grains. PFZs form around the  $\eta$  and  $\eta'$  precipitates near the PFZs are coarser.



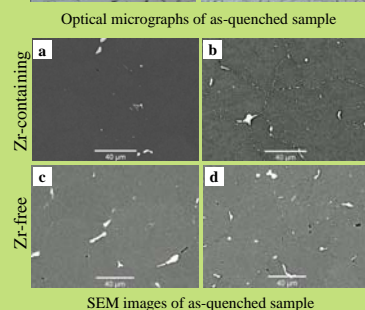
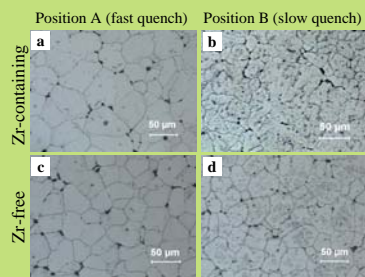
- The unrecrystallised zone consists of two types of subgrains. One has an average size of 0.5–1  $\mu$ m while the other has a larger average size of ~3  $\mu$ m.
- Slow quench induces coarse  $\eta$  particles at subgrain boundaries and inside the larger subgrains.

Table 1  $\eta'$  precipitates size in aged samples

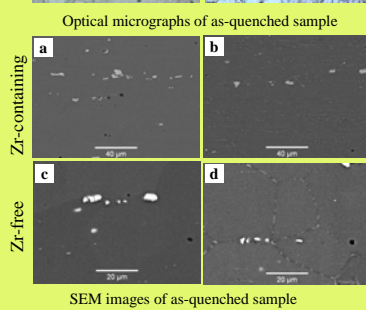
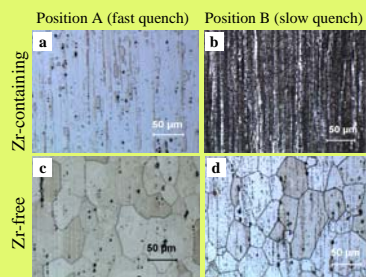
Alloy		$\eta'$ precipitate size (nm)	
		Position A	Position B
Zr-containing	cast	5.2 ± 1.1	5.7 ± 0.9
	wrought	4.7 ± 1.2	4.9 ± 1.3 15.6 ± 3.2 (in $\eta$ band)
Zr-free	cast	--	--
	wrought	5.9 ± 1.4	5.6 ± 1.2

## Conclusions

- Both Zr-containing and Zr-free 7055 cast alloys are not quench sensitive.
- The Zr-free 7055 wrought alloy is not quench sensitive while the Zr-containing wrought alloy has a significant quench sensitivity.
- Heterogeneous precipitation at grain boundaries during slow quench exerts little effect on quench sensitivity. Coarse  $\eta$  particles formed in recrystallised grains are mainly responsible for quench sensitivity of the Zr-containing wrought alloy.



- In the Zr-containing cast alloy, the slow quench induces heterogeneous precipitation at grain boundaries and inside grains.
- In the Zr-free cast alloy, the slow quench induces heterogeneous precipitation mainly at grain boundaries.



- In Zr-containing alloy, partial recrystallization occurred, slow quench induces heterogeneous precipitation both inside grains and at grain boundaries
- In Zr-free alloy, complete recrystallization occurred, slow quench induces heterogeneous precipitation mainly at grain boundaries