EFFECT OF SOLUTE CONTENT ON THE GRAIN STRUCTURE OF HIGH PRESSURE DIE CAST MAGNESIUM ALUMINIUM (Mg-Al) ALLOYS

Anumalasetty Venkata Nagasekhar [a], Mark A. Easton [b], Carlos H. Caceres [c]

[a,c] ARC Centre of Excellence for Design in Light Metals, Materials Engineering, The University of Queensland, Brisbane, QLD-4072, Australia

[b] CAST Co-operative Research Centre, Department of Materials Engineering, Monash University, Melbourne, VIC-3800, Australia

Introduction

- No systematic studies on the development of grain structure in hpdc Mg-Al alloys.

Materials & Methods

- Seven binary Mg-Al alloys with solute content of 0.47, 0.93, 1.82, 4.37, 5.51, 8.77, and 11.6 mass % Al.
- Grain structure characterization through electron back scatter diffraction (EBSD) by using JEOL 6460 LA SEM with HKL detector and Channel 5 software.

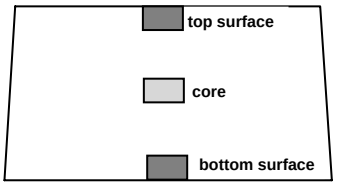

Fig.1 Sites of interest in the rectangular tensile cross-section for studying the grain structure

Results

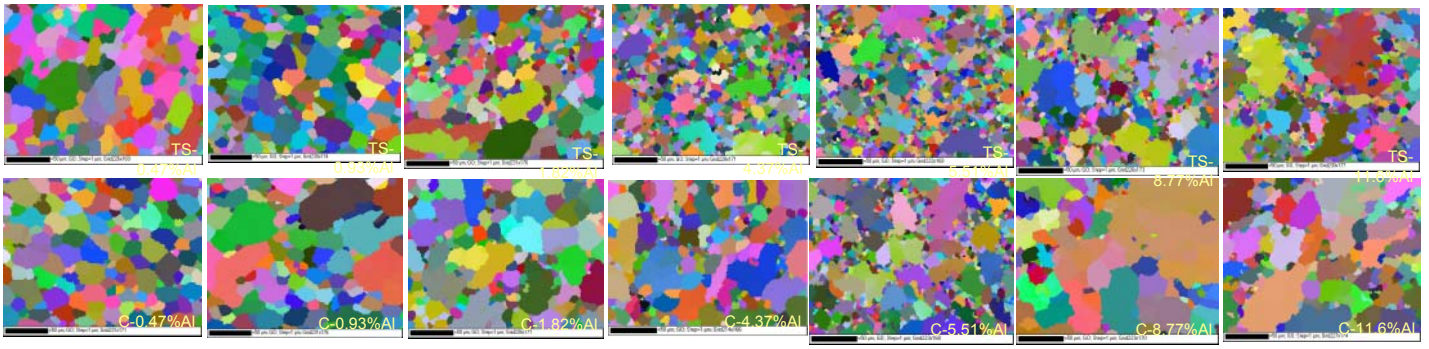

Fig. 2 Grain orientation maps from top surface (TS) and core (C) regions of different hpdc Mg-Al binary alloys

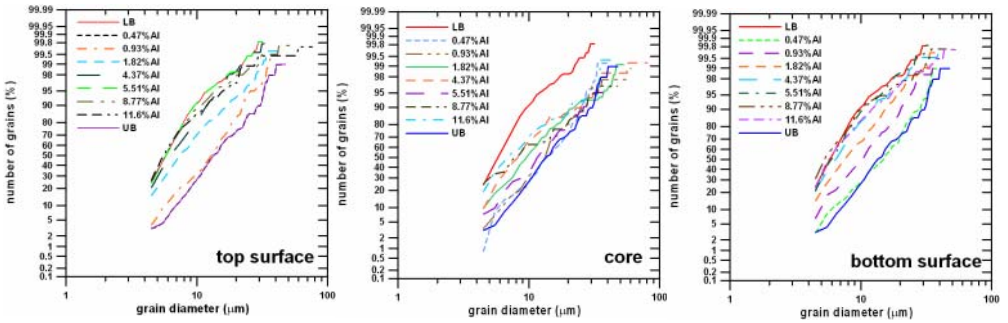

Fig. 3 Log normal probability plots of grain diameter Vs number of grains (%) at different locations across the tensile cross-section.

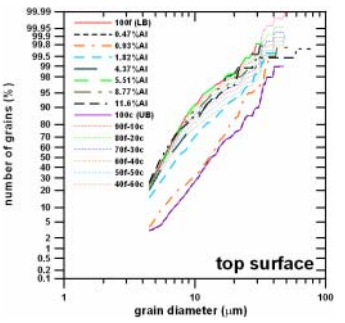

Fig. 4 Calculation of bimodal grain size distribution at top surface for different Mg-Al alloys.

- At the top and bottom surface regions the grain size is reduced gradually from 15 to 7 μm with increase in solute content; refinement is stabilized at 5.51 mass%Al.
- At the core grain refinement observed up to 4.37 mass%Al then increased due to presence of large number of externally solidified grains (ESG's) above 5 mass%Al.

Summary

- ✓ The grain structure is uniform across the cross section with solute content of < 1 mass%Al.
- ✓ For alloys with more than 1 mass%Al the grain structure is increasingly non uniform. A significant number of coarse externally solidified grains lead to a bi-modal structure.
- ✓ The grains formed inside the die cavity fits the relationship[1] of grain diameter (d) and growth restriction factor (Q)

$$d = a + b/Q$$

a and b are constants depends on solidification conditions

- ✓ Coarse ESG's are more likely to form in alloys with large solidification ranges.

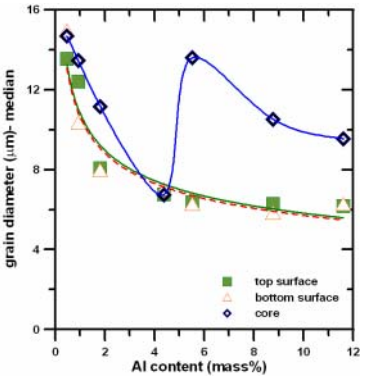

Fig. 5 Grain diameter as a function of solute content

References

1. Y.C. Lee, A.K. Dahle, D.H. St John, Metallurgical and Materials Transactions 31A (2000) 2895-2906.