New grain refiner for Mg casting alloys

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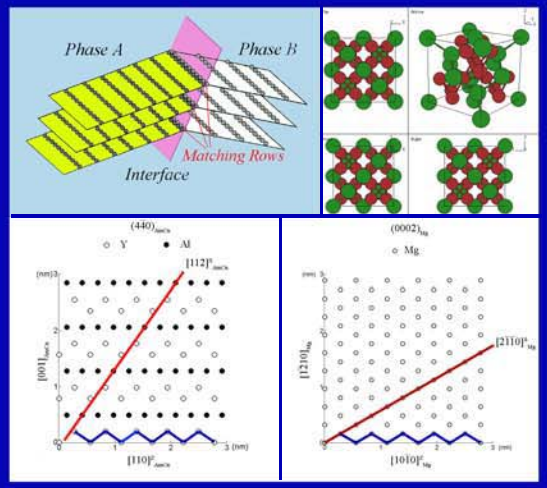
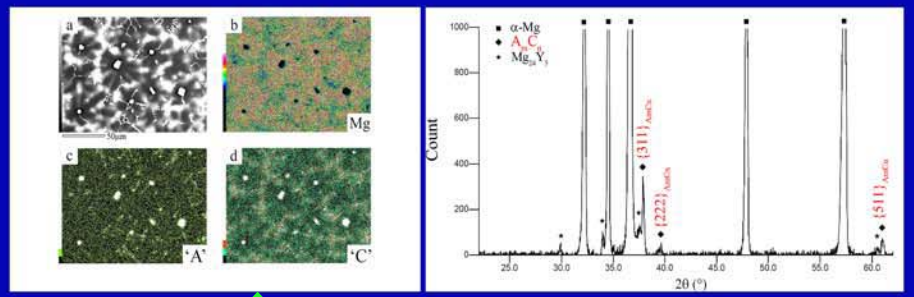
Grain refiner design

The edge-to-edge matching model (top left) has been applied to Mg casting alloys and a potential grain refiner candidate, A_mC_n (top right) has been predicted. Two pairs of close-packed rows, $[112]^S \mid [2\text{ -1 -1 }0]^S$ and $[110]^Z \mid [1\text{ 0 -1 }0]^Z$ have almost the same interatomic spacing, and they will be the matching rows lying in the interface (bottom left and right).



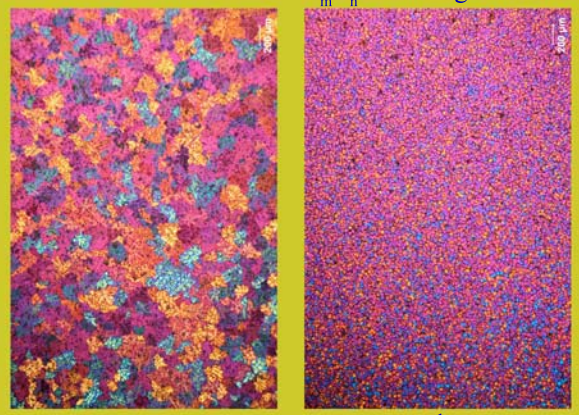


Heterogenous nuclation

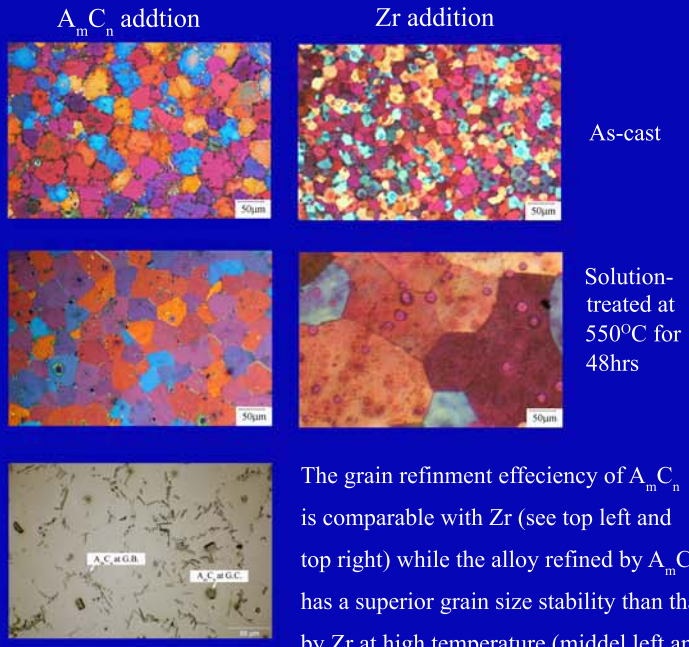
Left: the EDX mapping of the as-cast fine grains showing the heterogenous nucleation of Mg on A, C riched sites; Right: the XRD analysis confirms that the active nucleating particles are A_mC_n

Mg-10Y as-cast

After in-situ formation of A_mC_n in the Mg-10Y melt

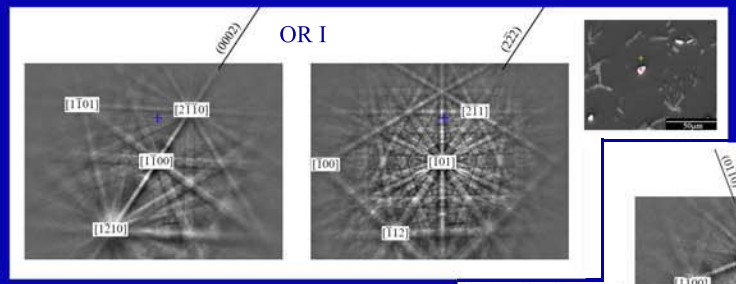


Grain size stability

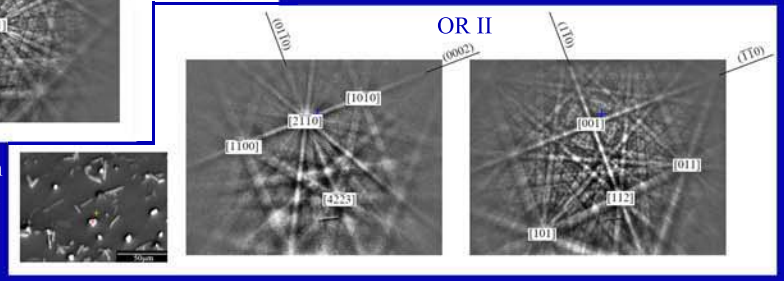


The grain refinment effeciency of A_mC_n is comparable with Zr (see top left and top right) while the alloy refined by A_mC_n has a superior grain size stability than that by Zr at high temperature (middel left and middle right). It may be attributed to the large amount thermal stable GB A_mC_n particles those do not participate the grain refinement (bottem left)

Crystallography



Two Orientation relationships (ORs) were identified by EBSD technique between A_mC_n nucleating particles and their Mg-10Y matrix across over 50 grains.



OR I (top) is close to the Crawley OR, accoun ting for 90% cases while OR II (right) has not been reported yet. Both of them are consistent with the pricdictions by the model.

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