“Aluminium Niobium – A Foundry and Master Alloy Manufacturer’s Perspective”

Henry Dickinson
Norton Aluminium
UK
Norton Aluminium – Foundry & Master Alloy Manufacturer
A presentation at the Charles Hatchett Seminar 13th July 2016
Background

- UK’s leading manufacturer of aluminium foundry alloys
- Full range of foundry alloys – LM series, ADC series, AA series, etc. High purity (Fe 0.01max);
- Gas-fired Tilting rotary furnaces & electric induction furnaces
- LME registered, brand “NA”
- Customers – Alcoa, Honda, Nissan, Toyota, Rolls Royce Aerospace
- Wide range of scraps processed ~1000 tonnes per month
- Focus on clean metal, tight elemental ranges, consistency
- Small batches; rapid cycle times
Aluminium Niobium Boron Potential Applications

• Pre-refined Pressure Diecasting Alloys
• Special Automotive Alloys, eg. cylinder heads and turbine wheel castings
• High performance aerospace alloys
• Wheel alloys
• Wrought alloys
World Market / Customers

• 10 million tonnes annual demand for secondary foundry alloys
• Europe 3.5m tonnes
• USA 2.5m tonnes
• China 2.5m tonnes
• India 0.8m tonnes
• Other 0.7m tonnes
Al-5Ti-B Addition Point in Industrial Process

Melting Furnace → Holding Furnace → In-line metal treatment → D.C. casting of billets or slabs

Waffle

Coiled Rod
Injected against flow of metal to allow sufficient time for dissolution

Nugget or Cut Rod
Laid in launder for “boost” at critical start-up phase

Ref: Thistlethwaite, LSM, TMS Workshop, 2008
Grain refiner

Foundry melts these ingots, adds grain refiner & cast into parts

Al-Si alloy parts manufacturer

cast

Inoculated Al-Si alloys ingots

Grain refiner

Al-Si alloy parts manufacturer

cast

Al-Si ingot manufacturer
Al-Nb-B phase diagram

Projection of liquidus surface for the entire Al–B–Nb system (a) and for the Al corner in double logarithmic scale (b) (isotherms are given in K): points in (a) denote the experimental data on primary-solidified phases.
Required Master Alloy Production Technologies

- **Induction Furnace**
  - High Power – up to 1500°C required
  - High-Temperature, non-wetting crucible
  - High stirring action for dissolution and to avoid settling out
  - Short launderers, heated and insulated
  - Integrated casting track

Spectrometer - ICP analytical capability
Introduction of Nb-B in to A357 ingots

1 tonne A357 melt

Al-Nb-B

A357 containing Nb-B
### Alloy composition with and without Nb/B

#### Analysis Certificate

**Supplied To:** BRUNEL UNIVERSITY  
**Specification:** A357  
**Date:** 10th May 2016

<table>
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<th>Melt No.</th>
<th>Cu</th>
<th>Mg</th>
<th>Si</th>
<th>Fe</th>
<th>Mn</th>
<th>Ni</th>
<th>Zn</th>
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</table>

#### Composition Percentage by Analysis

**Specification:** A357 + Nb/B  
**Date:** 10th May 2016

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WHERE .00 QUOTED ACTUAL < .01

GRAIN REFINED WITH BORON AND NIOBUM
A357 ingot cast from Al-Nb-B inoculated melt
A357 ingots inoculated with Nb-B

All ingots have finer grain structure
A357 ingot

Re-melt & cast

Coarse grain structure
A357 ingot containing 0.1% Nb-B

Fine grain structure
Remelting and casting of A357 ingot containing Nb-B
(~2h fading study)

Remelting and casting of A357 ingot containing Nb-B
(~3h – fading study)
A357 without grain refiner addition

A357 ingots containing Nb-B were Re-melted and Sand Cast

A357 with 0.1%Nb (sand cast)

Fine grain structure – Very similar in both cases
Primary or Recycled Base?

Primary – Fe < 0.15%, Cu < 0.05%, Mn < 0.05%, Si < 0.2%

Recycled – Fe < 0.5%, Cu < 0.2%, Mn < 0.2%, Si < 1%, Others < 0.2% each

Dilution in use – 50:1 or 100:1
Recycled material increases Fe content by only 0.005% (at 100:1), or Si content by only 0.01%.
Next Steps

• Determine and optimise processing parameters for commercial scale production
• Produce 20 tonnes of Al-Nb-B master alloy for priming of market to allow prospective customers to validate improvements in their own applications.
• Produce pre-refined batches of alloy in special and conventional alloys on demand.
• Monitor process conditions and anticipated life of refractory lining and other furnace consumables, with ongoing trials of alternative materials.
We look forward to working with you.

A warm welcome to visit our site.
Norton Aluminium Ltd
Norton Canes
Cannock
Staffs WS11 9PS
www.nortal.co.uk
Email: henryd@nortal.co.uk