**ALUMINUM, SILICON COPPER MAGNESIUM ALLOYS**

**WSD-M2A137-B1**
**WSD-M2A137-B2**
**WSD-M2A137-B3**
**WSD-M2A137-B4**
**WSD-M2A137-B5**

## 1. SCOPE

The materials defined by these specifications are a series of high silicon aluminum alloys suitable for gravity die casting, which contain copper, nickel and magnesium to enhance elevated temperature properties.

## 2. APPLICATION

These specifications were released originally for materials used for automotive pistons. Mechanical properties at elevated temperature and wear resistance increase through the grades to B4 and B5, which are recommended for the most arduous applications.

## 3. REQUIREMENTS

### 3.0 STANDARD REQUIREMENTS FOR PRODUCTION MATERIALS

Material suppliers and part producers must conform to the Company's Standard Requirements For Production Materials (WSS-M99P1111-A).

### 3.2 CHEMICAL COMPOSITION (Weight %)

| | B1 | B2 | B3 | B4 | B5 |
|---|---|---|---|---|---|
| Silicon | 8.5-10.5 | 11-13 | 11-13 | 14.8-18.0 | 17-19 |
| Copper | 2.0-4.0 | 0.7-1.5 | 0.7-1.5 | 1.9-3.6 | 0.8-1.5 |
| Iron | 0.8 max | 0.8 max | 0.8 max | 0.85 max* | 0.8 max |
| Magnesium | 0.5-1.5 | 0.8-1.5 | 0.8-1.5 | 0.5-1.0 | 0.8-1.3 |
| Nickel | 1.0 max | 0.7-1.3 | 0.7-1.3 | 0.35-0.8 | 1.3 max |
| Manganese** | 0.5 max | 0.5 max | 0.5 max | 0.45 max | 0.2 max |
| Zinc | 1.0 max | 0.5 max | 0.5 max | 0.90 max | 0.2 max |
| Titanium | 0.25 max | 0.25 max | 0.25 max | 0.20 max | 0.25 max |
| Chromium | --- | --- | --- | 0.10 | --- |
| Others each | 0.1 max | 0.1 max | 0.1 max | 0.1 max | 0.1 max |
| Total others | 0.5 max | 0.5 max | 0.5 max | 0.5 max | 0.5 max |
| Sodium/ Strontium (Total) | 0.5 max | 0.5 max | 0.5 max | 0.5 max | 0.5 max |
| Phosphorus | *** | *** | *** | *** | *** |
| Aluminum | Balance | Balance | Balance | Balance | Balance |

* High performance pistons may require lower iron; iron content must be balanced by Mn content, 2:1 respectively.

** Manganese content shall not be less than one-half the iron content.

*** Primary silicon refinement 0.0025 - 0.005% typical

| Date | Action | Revisions |
|---|---|---|
| | | |
| 2003 09 12 | Revised | Para 3.0 inserted; para 3.1, 3.7 and 4 deleted |
| 1993 09 29 | C10338491 | Released R. Cooper, EAC; P. Lee, NAAO |

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Supplied composition shall fall within the above ranges, and limits will be defined as part of the control plan. The control plan will also include modification, refining elements and processing detail.

**3.3 MECHANICAL PROPERTIES (Cast Test Bars)**
Room Temperature

| | | | |
|---|---|---|---|
| 3.3.1 | Tensile Strength, min<br>(ASTM E 8/ E 8M) | B1 & B5<br>B2, B3, & B4 | 180 MPa<br>200 MPa |

Note: Cast test bars shall be processed and coded in a manner comparable to the casting they represent.

| | | |
|---|---|---|
| 3.3.2 | Hardness (500 Kg load, 10 mm ball)<br>(ASTM E 10) | 90 - 130 HB |

**3.4 MECHANICAL PROPERTIES (Finished Components)**
Room Temperature

| | | |
|---|---|---|
| 3.4.1 | Tensile Strength, min | 180 MPa |

Test bars machined from any location.

The engineering drawing may designate a higher value for test bars from specified locations.

| | | |
|---|---|---|
| 3.4.2 | Hardness<br>(ASTM E 10) | 90 - 130 HB |

Rockwell F or Rockwell B measurements may be used on the finished component in lieu of Brinell readings where section thickness precludes using Brinell impressions. Hardness measurement locations shall be specified on the Engineering Drawing.

**3.5 MICROSTRUCTURE**
(ASTM E 3)

B1 and B2: Aluminum rich dendrites in an aluminum silicon eutectic matrix, containing uniformly distributed intermetallic compounds.

B3, B4 and B5: Primary silicon crystallites in a acicular aluminum silicon matrix, containing uniformly distributed intermetallic compounds.

Silicon particles must be randomly distributed and generally 10 to 50 micrometres in diameter, with no dimension to exceed 100 micrometres. High performance pistons may require finer silicon particle size. Surface depletion of primary silicon crystals should be kept to a minimum.

**3.6 HEAT TREATMENT (T5 or T6)**

Cool from an elevated temperature casting process or solution heat treatment and then artificially age to improve mechanical properties or dimensional stability or both. Age for minimum 4 hours, typically 8 - 12 hours at temperatures selected between 195 - 240 °C. Maintain selected ageing temperature to +/- 5 °C.

Specific heating/cooling and ageing practice or any deviation to the above shall form part of the component control plan.

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