



Aluminum Silicon Strontium



Aluminum based master alloys



MINEX

Minex Metallurgical Co. Ltd.



ISO 9001:2000

Pouring Reliability Into Your Melt - Alloying Solution in Foundry Industry

Aluminum Silicon Strontium Alloy

Alloy Description:

Aluminum Silicon Strontium master alloy is the alloy of Aluminium, Silicon and Strontium which is used as structural modifier of AlSi eutectic and hypo-eutectic casting alloy. AlSiSr addition modifies the structure of eutectic and primary silicon and the modification mechanism is attributed to changes in phase equilibria, modified nucleation and growth kinetics. The chemical composition and physical properties of the Aluminium Silicon Strontium master alloy is given below:

Chemical composition:

Alloy Grade	Chemical Composition (%)				
	Sr	Si	Fe (max)	Others (max)	Al
AlSiSr 5	4.5 – 5.5	6.5 – 7.5	0.25	0.5	Balance
AlSiSr 10	9 – 11	14 – 16	0.25	0.5	Balance

Other impurities- Mn, Ca, Zn, Na, Si, Pb **above hardeners are produced from 99.7% (Min.) purity of Al.

Physical properties:

Alloy Grade	Density (gm/cc)	Melting point (°C)
AlSiSr	2.64 – 2.70	700 – 710*

* melting point is not a relevant in normal use, the majority of master alloy and tablets produced by Minex Metallurgical Co. Ltd., dissolve in Aluminium rather than melt.

	Sodium Metal	Al-Si-Sr Alloy
Recovery	Low Variable and operator dependent	High and consistent
Contact time	Fast (20-40 min)	Slow (>2 Hrs)
Environmental	Fumes Refractory attack	Clean and fume free
Overmodification	Possible due to difficulty of control	Unlikely
Potency	Very High	High
Addition Level	50 ppm	250 ppm
Ease Handling	Must be protected from moisture	Unreactive with moisture if <20% strontium master alloy

Addition technique:

Remove heavy dross from melt surface and add appropriate amount of AlSiSr master alloy (At T 720 - 770°C) to the molten metal. Addition can be made either at treatment furnace or transfer ladle. After the dissolution of alloy, good stirring of melt is required to maximize modification and recovery.

Application:

Modifiers are added to eutectic and hypo-eutectic Al-Si alloys to refine the eutectic Si phase from one of angular platelets to fine fibers. This change in microstructure results in improved mechanical properties particularly strength and ductility aiding refinement in porosity.

Comparison of Sodium & Strontium Modifier

The first hypo-eutectic modifiers were based on Na, and are added as Na metal or encapsulated Na in Al foil. Due to high reactivity and low solubility of Na in Aluminium (recoveries low up to ~20%) and gradual loss of Na with time (fade) results in process difficulties. The modifying action of Na practically disappears only after few remelts, where as modifying effect of strontium does not fade on holding at elevated temperatures.

Table 1 Comparison of Sodium and Al-Si-Sr Modifier

Effect of Modification on Silicon Particle Morphology

In unmodified alloy, the silicon grows as plates that can be lamellar or acicular. Lamellar structures are nearly parallel and thin plates, while acicular structures are randomly distributed plates with much massive structure. At an unmodified condition, thin silicon plates can be seen cutting through the aluminum matrix. (fig.1)

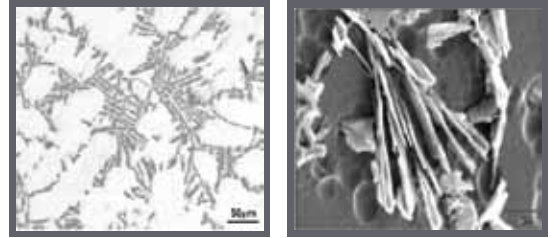


Figure 1 Unmodified alloy (0.0003%Sr) lamellar structure (a) 200x (b)1500x

Partially modified structures are the coexistence of flake and fibrous silicon mixed, cellular or banded structure. They can be obtained by a combination of slow solidification rates (bet. 1 & 25 m/s) and low strontium concentration. At low strontium concentration and during slow growth, the eutectic is able to reject enough strontium ahead its interface to avoid transforming to fibrous morphology. (fig.2)

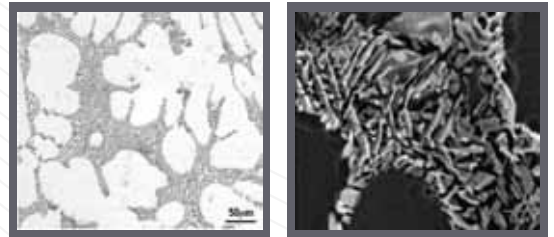


Figure 2 Partially modified structure (0.0026%Sr) (a) 200x (b)SEM deep etched 1500x

When the addition of strontium exceeds the amount necessary to produce a fully modified structure, it exerts a deleterious effect on the mechanical properties of the alloy. Strontium overmodification is much more subtle and difficult to identify by microstructural analysis. In overmodified alloys, elongated silicon particles that no longer grow as well as refined fibers can be observed. However the formation of Sr-rich phase is reported in strontium concentration above 0.03%

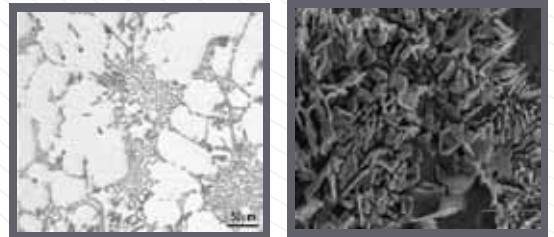


Figure 3 Fully modified structure (0.0075%Sr) (a) 200x (b)SEM deep etched 1000x

In well modified structure silicon grows in a coral-like form (fibrous) that looks like small individual round-shaped particles in polished surface. The modification treatment affects not only size and shape of the particle, but also its distribution. Ideal concentration of strontium results in a fibrous eutectic structure, well refined and homogenous. (fig.3)

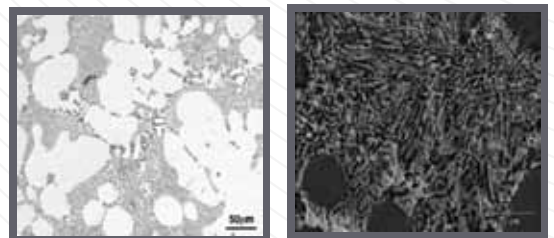


Figure 4 Over modified structure (0.0130%Sr) (a) 200x (b)SEM deep etched 1000x

Effect of strontium on reliability of casting

The average mechanical property results after the various treatments are shown in Fig. 12 these show that the melt treatments lead to improved mechanical properties in GDC A319 alloy. The addition of modifier gives an increase in UTS and elongation values, treatments have resulted in reduction in scatter as evidenced by an increases in Weibull modulus from 5.9 (untreated) to 17.6 (modified)(Fig.6). Similarly the Fig.5 shows an increased fracture toughness value for Sr-modified alloy A357 compared to unmodified alloy.

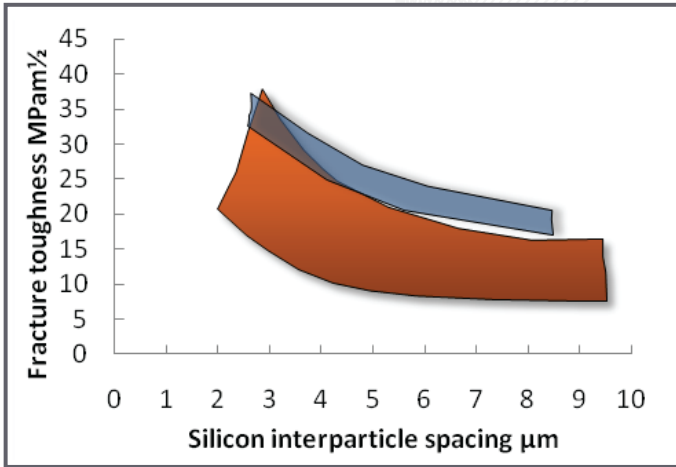


Figure 5

fracture toughness of alloy A357 (Al -7Si - 0.5Mg) with and without Sr modification

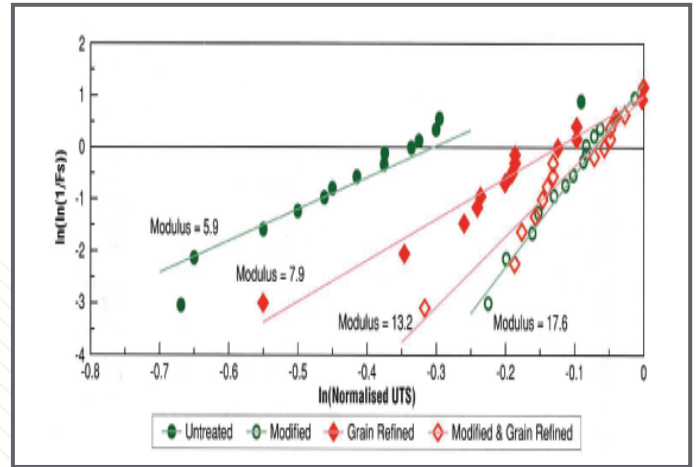


Figure 6

Effect of melt treatment on Weibull plots of UTS of Gravity Die Castings A319

Available form:

Forms	Std. Size (mm)	Std. Weight (gms)
Piglet	60×45×45	250±10
Waffle plate		8 – 10

Different shape & Size can also be produced as per customer requirement.

Storage:

Use cool and dry place to store the material.

Safety:

Material Safety Data Sheet can be supplied on demand. Material is not hazardous but normal safety precautions to be followed.

Packing:

Piglet	Waffle plate
25 Kg gunny bag/500 Kg Jumbo Bag (or as per customer requirement)	500 Kg strapping with palette (or as per customer requirement)