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3.2.2. ***Number of books and chapters in edited volumes/books published and papers published in national/ international conference proceedings per teacher during the year***

BOOKS PUBLISHED

Sr. No.	Name of the teacher	Title of the book/chapters published	Title of the paper	Title of the proceedings of the conference	Year of publication	ISBN/ISSN number of the proceeding	Name of the publisher
1.	P. W. Ambekar, P. Y. Deshmukh, P. A. Tiwari and S. B. Misra;	Cogitations on advances in physical and mathematical sciences	An Effectiveness of AlSr Alloy in the Modification of Eutectic Si Phase in AlSi Alloy,	Cogitations on Advances in Physical and Mathematical Sciences, Vinayak Publishers, Agra.	2022-2023	9789391267452	Shree Vinayak Publication, Agra- 282007
2.	Dr. Mrs. Vaishali Meshram	A Chemistry of Transition Metals	**NA**	**NA**	2022-2023	978-93-95021-03-6	Cambridge Book House

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An Effectiveness of Alsr All On In the Modification of Eutectic Si Phase in Alsialloy

P. W. Ambekar,P. Y. Deshmukh, P. A. Tiwari and S. B. Misra

ABSTRACT

AlSr alloy was prepared by melting route in an Induction Furnace with Sr5% and 10%. Scanning Electron Microscopy (SEM) along with EDS analysis confirms the uniform distribution of Al_4Sr phase throughout the master alloy for AlSr5% as well as AlSr10%. The combination of AlSr master alloy with AlTi alloy improves the mechanical properties of AlSi alloy. The 0.03% addition of AlSr10% alloy converts the eutectic Silicon phase morphology of AlSi alloy from coarse plate-like to fine fibrous networks. These fibrous structures in combination with α-Al8Fe2S along the grain boundary makes the strong bonding between two grains. Because of this strong interaction between two grains along with the reduced grain size owing to the formation of $TiAl_3$ particles imparts better mechanical properties and better surface finish to AlSi alloy.

Keywords:

Eutectic Si phase, refinement, modification, Al_4Sr phase, Spinel (α-Al8Fe2S) phase

Introduction:

The study was done on A356 alloy with La and Ce were added individually and /or in a combined way to study the modification behaviour. But it was observed that to bring the modification in the eutectic Si phase Sr is also necessary in combination with La and Ce [1]. To achieve the desired degree of structural refining in the cast alloy the quantity of modifier addition is decided. This amount is decided based on the original amount of elements present in the alloy before adding any master alloy in a particular AlSi alloy. This is based on the cooling rate and the degree of structure refinement desired. Normally 0.015 % to 0.05% (w/w) is added [2]. The aluminum strontium alloy is used as an inoculant for gray and ductile iron. Some of the inventors have worked on the modification of eutectic phase in AlSi alloy or modifying intermetallic phases in wrought aluminum alloys[3]. A large amount of work is done on the morphology and size of the Al4Sr phase in modifying the eutectic Si phase. There are two ways for that, one is direct reaction and another is direct reaction-hot extrusion. In direct reaction–hot extrusion, the Al4Sr phase exhibited a homogeneous distribution of Al4Sr phase in the Al matrix with small size and roundish shapes, which ensured the AlSr master alloy wire has advantageous effect of high recovery, good reproducibility and good workability. However, in the case of the traditional direct reaction process, the Al_4Sr phase was in large size with shapes of rectangular stripe and plates, which limited the Sr content increasing due to the brittleness of the AlSr alloy. [4]

Materials and Method:

AlSr alloy with various Strontium % such as 5% and 10% were made in an Induction Furnace of 250 KW power (Inductotherm make) with 99.9% pure Aluminum ingots and 99.9% pure Strontium metal. Aluminium ingot was first melt and then degassing was done with hexachloroethylene tablet for 2 minutes to remove entrapped oxygen and hydrogen. Pure strontium metal was added immediately once the Aluminum melt reaches the temperature of 750°C. The melt is stirred with graphite stirrer for 5 min with 250 rpm to achieve the uniform mixing of Strontium with Aluminum at eutectic combination. The optical metallography of each AlSr master alloy was examined with Carl Zeiss microscope with AXIO VISION Software and based on that AlSr10% was chosen for the eutectic Silicon modification purpose in AlSi alloy, with least porosities. The presence of uniform distribution of Al_4Sr phase and detail metallography was carried out by SEM-EDS (JEOL make).

AlSr 10% alloy was added in the AlSi alloy with the addition rate of 0.02-0.03%. The chemistry and the change in the metallography, before and after addition of AlSr10% and AlTi10% master alloy was examined in detail. The experimental findings are mentioned in the following section.

Results and Discussion:

AlSr alloy was observed to have lot of porosities owing to gas evaluation during making of an alloy due to exothermic reaction. But these porosities does not affect the effectiveness of AlSr alloy in the modification of eutectic Silicon phase morphology from coarse plate-like to fine fibrous networks. Along with AlSr10% alloy AlTi10% was also added in the AlSi alloy to achieve the required mechanical properties with the addition of $TiAl_3$ particles. These $TiAl_3$ particles achieve the refinement of grains achieving the AlSi alloy with strength and hardness.

The elemental analysis of AlSi alloy before and after addition of AlSr10% and AlTi10% is as shown in Table 1

From the Table 1 it shows that, with 0.03% addition of AlSr10% alloy and with 0.2% addition of AlTi10% alloy, there is hardly any change in the chemistry but from Figure 1 and Figure 2 it seems that there is substantial change in the morphology of the Silicon eutectic phase as well as grain boundary phase transformation.

Table 1: Elemental composition of AlSi alloy before and after addition of AlSr10% and AlTi10% alloy

Elements	Before addition of master alloys	After addition of master alloys
Copper	2.877	2.768
Magnesium	0.236	0.218
Silicon	6.571	6.139
Iron	0.569	0.6
Manganese	0.176	0.186
Nickel	0.026	0.025
Zinc	0.343	0.323
Lead	0.026	0.019

Tin	0.025	0.018
Titanium	0.131	0.163
Chromium	0.036	0.037
Calcium	0.0015	0.0012
Phosphorous	0.0025	0.0029
Strontium	0.0032	0.0067
Vanadium	0.012	0.015
Aluminum	88.931	89.448

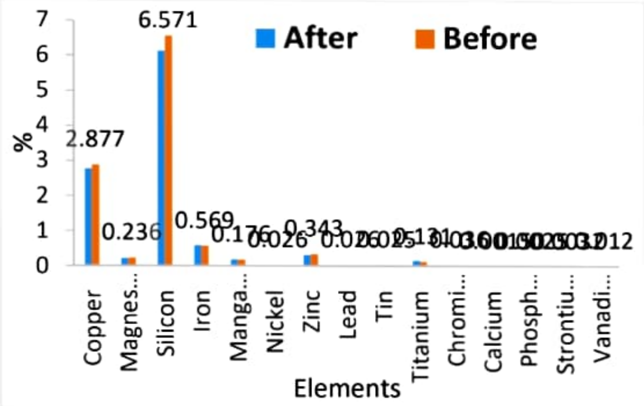
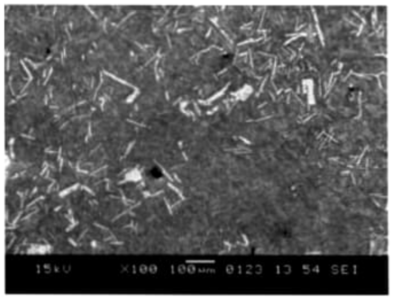
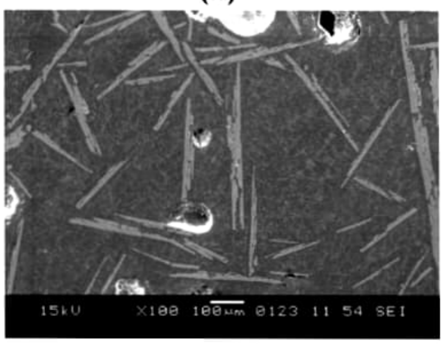


Figure 1: Graphical representation of the change in the elemental composition of AlSi alloy before and after addition of AlSr105 and AlTi10% master alloy



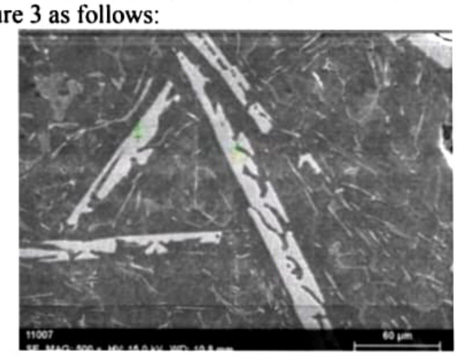
(A)



(B)

Figure 2: Scanning Electron Microscopy of AlSr alloy with 5% Strontium (A) and 10% Strontium (B) addition displaying the uniform distribution of Al_4Sr phase

The confirmation of Al4Sr phase was done by EDS analysis as shown in Figure 3 as follows:



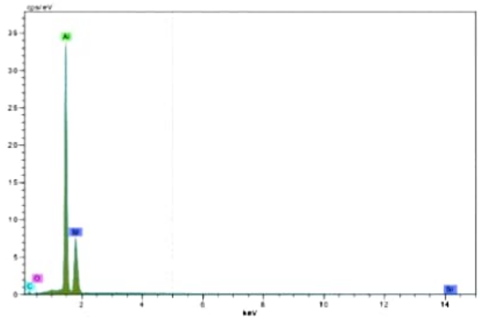
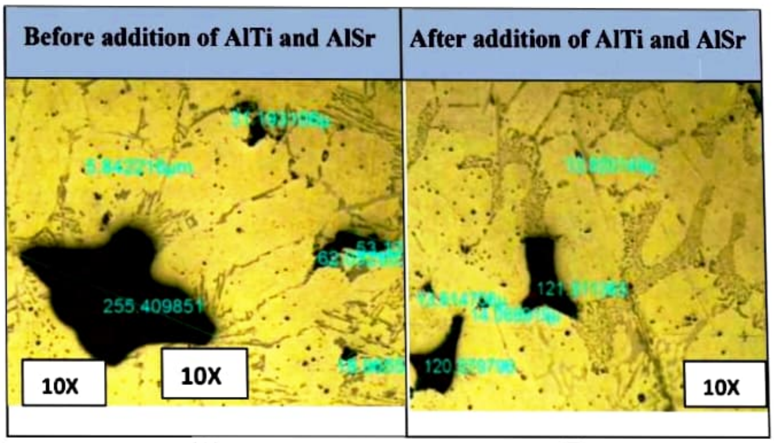


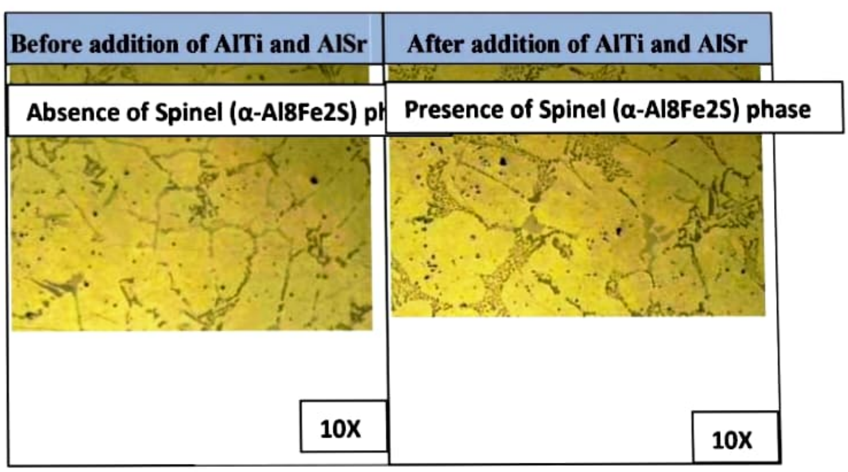
Figure 3: Elemental Dispersive Spectroscopy (EDS) of Al4Sr phase in the AlSr10% alloy

The Al_4Sr phase has uniform distribution through out the AlSr alloy in both cases. As shown in the Figure 2, the size of Al_4Sr phase in AlSr5% is in the range of 50 µm to 140 µm whereas in AlSr10% is in the range of 100 µm to 500 µm. The size of the voids/porosities before the addition of Ti and Sr were of larger size, 255 µm to 392 µm and after the addition of Ti and Sr the voids/porosities were reduced to the size of 120 µm to 162 µm as shown in the following Figure 4. Figure 4 (B) shows the reduction in the size of voids/porosities because of the formation of spinel (α-Al8Fe2S) phases at the grain boundary after the addition of AlTi and AlSr. The presence of large voids/porosities in the AlSi alloy makes its mechanical properties very week as shown in Figure 4(A).



(A) (B)

Figure 4: AlSi alloymetallography at 10Xbefore (A) and after (B) addition of AlTi10% and AlSr10% alloy displaying the reduction of porosities



(A) (B)

Figure 5: AlSi alloymetallography at 10Xbefore (A: Absence of Spinel (α-Al_8Fe_2S) phase along the grain boundary, unmodified) and after (B: Presence of Spinel (α-Al_8Fe_2S) phase along the grain boundary)

addition of AlTi10% and AlSr10% alloy displaying the modification and grain size reduction

This presence of α-Al8Fe2S along the grain boundary (Figure 5) and reduced porosities gives the required mechanical strength and surface finish properties to AlSi alloy.

Conclusion:

The presence of spinel phases along the grain boundary makes the alloy's mechanical properties (hardness, tensile strength, % elongation) very strong. Though there is no major difference in the grain size (71.39 µm -71.58 µm) of the alloy, these spinel phases formed due to α-Al8Fe2S makes the strong bonding between the two grains. The absence of the α-Al8Fe2S in the alloy makes the bonding between the grains week leading to failure of the engine or automobile parts. The addition of Sr in the form of AlSr alloy modifies the eutectic Si phase (morphology and microstructure) from large platelet like structure to fine fibrous structure, which increases the mechanical and thermal properties of the final casting. The addition of 0.03% strontium makes a modest improvement to the yield strength, ultimate tensile strength and elongation percentage values, and the scatter of these properties. Titanium (Ti) is used to refine primary aluminum grains. Titanium, added in aluminum alloy, forms TiAl3, which serves to nucleate primary aluminum dendrites. More frequent nucleation of dendrites means a large number of smaller grains.

Future scope of reference:

The next research plan is to carry out the mechanical testing such as hardness, tensile strength, impact strength varying the addition rate of AlSr10% and AlTi10%

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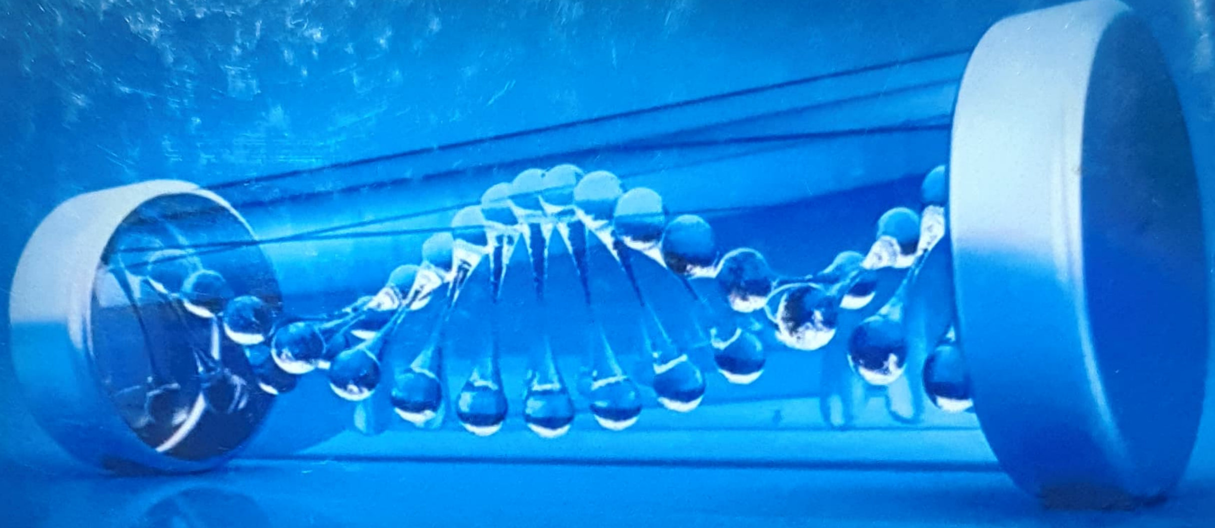

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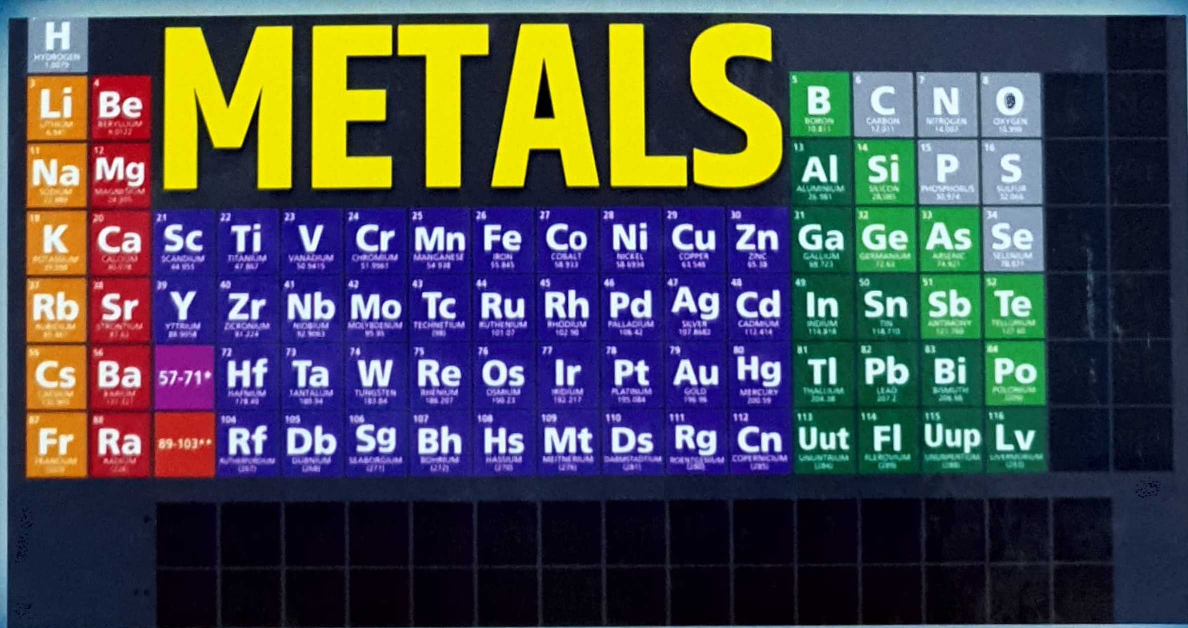

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About the Book:

Transition metal, any of various chemical elements that have valence electrons—i.e., electrons that can participate in the formation of chemical bonds—in two shells instead of only one. While the term transition has no particular chemical significance, it is a convenient name by which to distinguish the similarity of the atomic structures and resulting properties of the elements so designated. They occupy the middle portions of the long periods of the periodic table of elements between the groups on the left- hand side and the groups on the right. Specifically, they form Groups 3 (IIIb) through 12 (IIb).

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