# INVESTIGATION OF MECHANICAL AND THERMAL PROPERTIES OF STRONTIUM MODIFIED ALUMINUM (AA7175) ALLOY.

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**Abstract**
**Aluminum exhibit many attractive properties like low weight to strength ratio, good corrosion resistance etc. but pure aluminum alloy has low strength properties. This can be overcome by adding some alloying elements like Nb,Sr etc. the addition of strontium has beneficial results which changes the morphology of silicon present in the aluminum thereby increasing strength however, only 0.2%Sr is limited as excess strontium form as impurities in castings. The strength of this alloy is better improved by treatment process called AGING with different time and temperature conditions these heat treated alloys have beneficial effects on strength and other properties.**
**Keywords: AA7175, strontium addition, Age treatment**

## 1. Introduction

Aluminium and its alloy are vital in aerospace application due to low weight to strength ratio and it is also used in construction applications. A fresh film of aluminium is widely used as reflector in many application [1]

Age hardening is a tempereature dependant process extensively used for strengthening of aluminium alloys. This process flows in three different process namely solutionising, quenching and aging it may be artificial or natural aging. This type of strengthening is done for the elements having decrease in their solid solubility as temperature decreases[2].

Strontium converts needle like structures into round particles or spherical form there by avoiding large grain boundaries and then impedes for the growth of ductile fracture along grain boundries there by increasing strength of the aluminium alloys. Pure aluminium alloy possess low mechanical properties. However its properties can drastically be increased by work hardening like cold rolling and precipitation hardening. When aluminium alloy is exposed to atmosphere alloying elements form thin oxide layer over its surface so formed layer which acts as a resistive layer for corrosion. It is also high resistant to withering. Alkalis are prone to cause destruction of oxide layer of the alloy which is formed on its surface

## II literature Survey

Addition of strontium(Sr) in the alloy promotes segregation of Al and Zn in liquid phase during solidification and leads to grain refinement of Al and Zn in AZ31 alloy. Effect of strontium (Sr) is to increase the coefficient of distrubution of Al in AZ311 alloy and it also improves GRF value of an alloy.
The coefficient k0 is used for equilibrium solidification and it is defined as the ratio of solute concentration in solid phase to liquid phase. It is observed that addition of strontium has a effect on liquid phase. With the addition of .04%wt of Sr under temperature of 850k, solid solubility decreased from .04%wt and .0198%wt to .003% and .0045%wt respectively. As we increase the Sr content solid solubility of Al and Zn decreases indicating that it promotes the segregation of Al and Zn in liquid phase. It is also known that dendrite boundary is the last zone of solidification[6].

Of all other modifier strontium (Sr) is the best solution becuase it has high recovery rate, good modification performance and long modification period. Because of this Al-Sr master alloys are widely used in many foundry and other industry. SEM with 15Kv is used to examine the microstructure and direct reading spectometer is used to study the Sr content in the aluminium alloy. Modification is depends on the stability of phases which is very closely related to morphology of the structure[7].

Under normal conditions silicon appeared as needle like structures act as a sites for stress concentration leading to lowering of mechanical properties. strontium segregates the Cu phase and keeps it remain out of solid solution during solution treatment. After solution treatment the specimens are subjected to natural aging at different heating conditions. Natural aging was done for 12hours followed by artificial aging for 3-6hours. But addition of strontium increase the uniformly distribution of Cu and helps to formation of fine precipitates in the alloy matrix. By looking at it uniform distribution of precipitates depends on selection of solutionizing concentrations like temperature etc.

T6 heat treatment condition is applied for age treatment for different period. The results showed that hardness increased. Artificial aging at higher temperature gives good results that is uniform distribution of fine precipitates and these are very much required elements for increasing of mechanical properties. Strontium has the effect of segregating Al-Cu phase and these segregated Cu solute atoms flows around matrix. When alloy is subjected to solution treatment these segregated particles get precipitated and these become hinder the moment of dislocation causing resistance to applied stresses and increase the strength of the alloy. High magnification requires for clear images[21].

## III Experimental procedure

In the present study, experiments are conducted on age hardened aluminium (AA7175) alloy samples. Strontium is added in various percentages during casting and allowed to solidification. Then samples are subjected to heat treatment.

In our work heat treatment furnace is used for age hardening purpose. Two conditions are applied in heat treatment (1): T6 condition (2): T77 condition.

In T6 condition, samples are solutionized at $470^0$ C for 2 ½ hour followed by quenching in water at room temperature. Then the samples were aged artificially at $120^0$ C for 24 hours followed by quenching in water at room temperature.

In T77 condition, samples are solutionized at $180^0$ C for 1 hour followed by quenching in water and then samples are naturally aged at $120^0$ C for 24 hours followed by quenching in water at room temperature.

After heat treatment as per the above two steps, the required tests are conducted and obtained the results.

**Fig 1.4.1 Heat treated Specimens**

**Fig 1.4.2 Heat treatment Furnace**

Samples are prepared according to the standards ASTM E8 for the following tests:

1) Tensile test
2) Hardness test
3) Coefficient of thermal elongation test

**Tensile test**: It is carried out in computer controlled TENSOMETER. Here specimens were held between shackles at the end and load is applied gradually which gives various readings and graphs are plotted.

**Hardness test**: for this test samples are prepared according to the standards.

Dimensions are 15mm dia* 10mm length. Rockwell hardness test is conducted and "B "scale is considered.

**Thermal elongation test:** It is conducted in DILATOMETER with the sample size of 42 $\pm$ 1 mm length* 8mm dia. Heater was set at $270^0$ C and elongation is recorded.
From the obtained elongation CTE is calculated from the Formula. CTE = (1/L)*DL/DT .

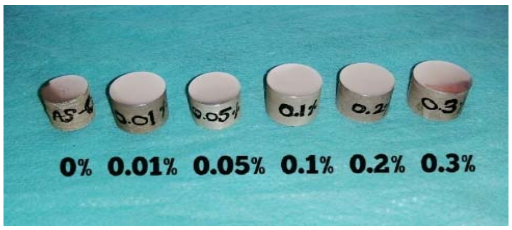


**Fig. 3 Specimens for hardness test**

**Fig. 4 Specimen in furnace tube**

## III Results and Discussion

Hardness of the Cast Alloy AA7175 obtained for ASCAST is 68.38 HRC, It gradually increased to 81.8, 83.02, and 85.98 HRC for 0.02, 0.05 and 0.1% of Sr additions respectively, It slightly reduced for 0.20% and 0.30% with HRC of 77 and 80.5.
Ultimate Tensile strength of Heat treated ASCAST is 177MPa and obtained a steep rise in UTS to 348MPa for 0.02% of strontium modified Heat treated AA7175 alloy, whereas the obtained UTS for 0.05%Sr, 0.10% Sr, 0.20%Sr, 0.30%Sr are in the same range of 315 to 355MPa respectively.

CTE in decreased constantly from $1.89 \times 10^{-05}$ to $2.06 \times 10^{-05}$ as shown in below graph, from Ascast to 0.3%Sr which indicates addition of strontium and aging have benificial effects on the properties and it is observed that values are doubled.

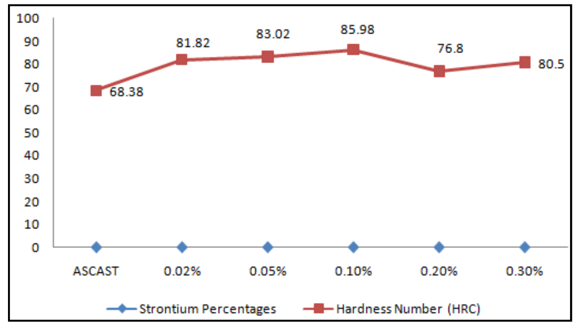


**Fig. 4 Hardness Test Result**

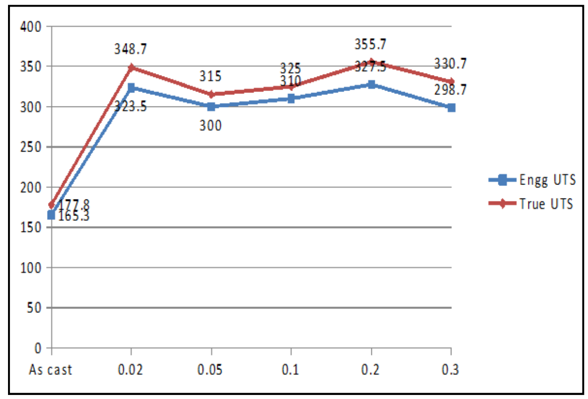


**Fig.6 Tensile test results**

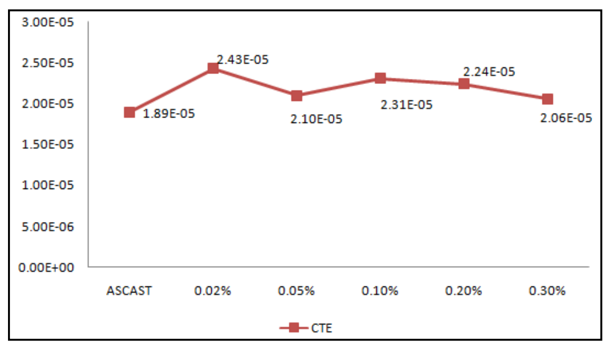


**Fig. 7 Coefficient of thermal Elongation Test Results**

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