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STUDIES ON LM-6 ALLOY SUBJECTED TO MODIFICATION AND VIBRATION USING MECHANICAL STIRRER

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ABSTRACT

All industries especially aircraft and automobile industries are presently looking for light metal or alloys having high strength to weight ratio and creep resistant properties. Attempts are still continuing to strengthen these light metal or alloy by different means such as modification, heat treatment, work hardening, grain refining and also by using different casting techniques. In this thesis work an attempt has been made to improve the properties of LM-6 alloys modified with sodium and at stir casted condition. Stirring of molten metal has been done before the solidification of molten metal take place. LM-6 alloys is a eutectic alloy contain 10 -13% by weight of silicon. Aluminium has a density of 2.7 gm/cc and Silicon has a density of 2.3 gm/cc. So silicon is one of those elements that can be added to aluminium without loss of weight advantage. Al-Si alloys can be sand cast, die-cast and suitable for low pressure casting. Sufficient literatures are not available to enlighten us the properties of this alloy with modification with stir casting. So present work is carried out to study changes in the properties of the LM6 alloy with time and speed of stirring with modification.

INTRODUCTION

Aluminium is a metallic element having the chemical symbol Al, with atomic number 13. Aluminium is the world's most abundant metal and is the third most common element coming after oxygen and silicon, comprising 8% of the earth's crust. . Pure Al have Low density 2700 kg/m3 comparing to steel which has 7900 kg/m3,The versatility of aluminium makes it the most widely used metal after steel. Pure aluminium is soft, ductile, corrosion resistant, and has a high electrical conductivity. It is widely used for foil and conductor cables, but alloying with other elements is necessary to provide the higher strengths needed for other applications. Aluminium is one of the lightest engineering metals, having a high strength to weight ratio superior to steel. By utilising

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various combinations of its advantageous properties such as strength, lightness, corrosion resistance, recyclability and formability, aluminium is being employed in an ever-increasing number of applications. This array of products ranges from structural materials through to thin packaging foils. The aluminium-silicon alloys possess exceptional casting characteristics, which enable them to be used to produce intricate castings of thick and thin sections. Fluidity and freedom from hot tearing increases with silicon content and are excellent throughout the range. The irresistance to corrosion is very good, but special care is required in machining. In general, the binary alloys are not susceptible for heat treating; at elevated temperatures their strength falls rapidly. Although they possess medium strength, their hardness and elastic limit are low but they possess excellent ductility. LM6 is suitable for Marine 'on deck' castings, water-cooled manifolds and jackets, motor car and road transport fittings; thin section and intricate castings such as housing, motor casings and switchboxes; for very large castings, e.g. cast doors and panels where ease of casting is essential; for chemical and dye industry castings, e.g pump parts; for paint industry, food and domestic castings.

METHODOLOGY

The LM 16 alloy is melted and undergoes modification by adding sodium and the molten metal is stirred using a mechanical strainer at various speed and time and the metal has been casted in various shapes in order to undergo mechanical properties testing

EXPERIMENTAL DETAILS

In this first stage the degassed grain refined and modified molten metal is poured directly into the mould without any stirring. In second stage the molten metal is hand stirred by using a clay coated (to withstand the temperature) hand stirrer.In third stage the molten metal is stirred by using an electric stirrer .which is run by an electric motor. The time of stirring is varied up to 7min after that the liquid metal starts to solidify. Speed of the stirrer also varied at different stirring time. The test bars produced by different condition is studied for tensile strength hardness and microstructure.

- Furnace for melting the metal
- The metal is melted in furnace with adding coverol and degreaser for avoid chemical reaction of alloy with air
- The modification process is done by adding sodium
- A mechanical stirrer in order to stir the molten metal with various speed and time
- After stirring the molten metal is casted BS1490 standard
- The casted specimen is then conducted various mechanical tests
- Universal testing machine is used to conduct tensile test

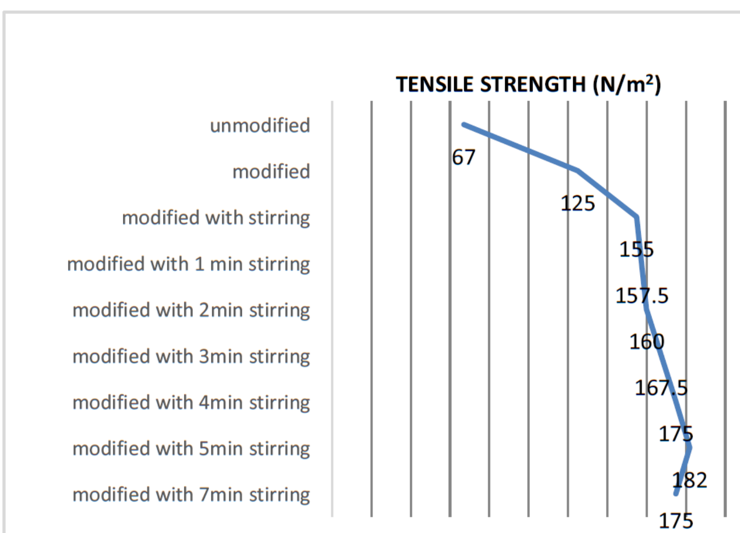
- Rockwell hardness tester is used to conduct hardness test
- Scanning Electron Microscope (SEM) is used to observe the microstructure

RESULTS AND DISCUSSION

Test bar castings have been produced with by varying the stirring time and speed. Stirring is done before pouring to mould. Test bars are also produced with and without modification to study the effect string speed modification. The details of investigation are given below and discussed.

TENSILE TEST

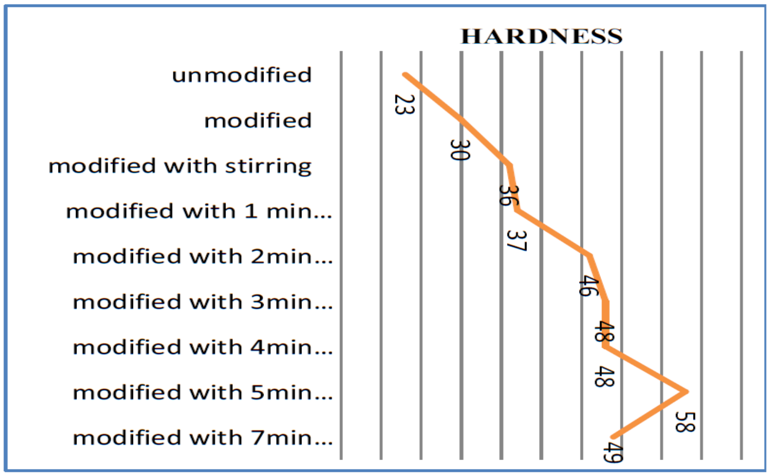
Tensile strength is measured by using universal testing machine (UTM). Load is applied on the test bar and failure of specimen will occurs at ultimate tensile load. Test bar for tensile test are made as per the ASTM standard. Tensile strength varies with stirring time and speed. Tensile strength increased with the time of stirring increasing. In unmodified Al-Si alloy, silicon is in the form of plates like structure with sharp edges. So whenever there is a formation of crack, it will propagate at a faster rate due to additional load. By treating the alloy with modification silicon structure become fibrous. Fibrous structure of silicon contributes higher ultimate tensile strength and hardness. Due to agitation by stirring cause wavy nature of metal flow results in grain refinement due to quick formation of seed nuclei in several sites. This is in turn brings grain refinement and thereby increase the tensile strength. With increase in stirring time and speed ultimate tensile strength also increases.



Graph of tensile strength variation with stirring time

HARDNES TEST

Rockwell hardness number for the specimen is checked with 1/16" steel ball indenter. The average value is taken and graph is plotted. Modification of metal with sodium improves hardness about 30%. Hardness number increase with the time of stirring action up to a limit. Stirring improves the hardness up to 5min and it decrease at 7min it may due to solidification. 5min stirred test bar shows the maximum hardness



Graph of hardness variation with stirring time

MICROSTRUCTURE

From microstructure analysis, it is found that in unmodified form silicon appears as course flakes as shown in Figure 1 although modification does not actually refines the grain size significantly. Modification breaks up this needle like structure within the grains and enables the fine fibre of silicon to segregate out of the aluminum. In unmodified LM6 alloy silicon dendrites are present unevenly and it contains larger grains compared to modified alloy. When the stirring action of the molten metal increases the grains are getting finer and equiaxed. Silicon particle are uniformly distributed over the metal. In modified LM6 casting dendrites of silicon particles are broken up into small particles as shown in Figure 5.5. When the stirring time increases fine grains of equiaxed shape is produced as shown in Figure 3. Further increase in stirring time increases grain refinement as shown in Figure 4 and Figure 5. Microstructure analysis reveals that fibrous structure is predominant in modification and grain refinement is predominant in stirring.

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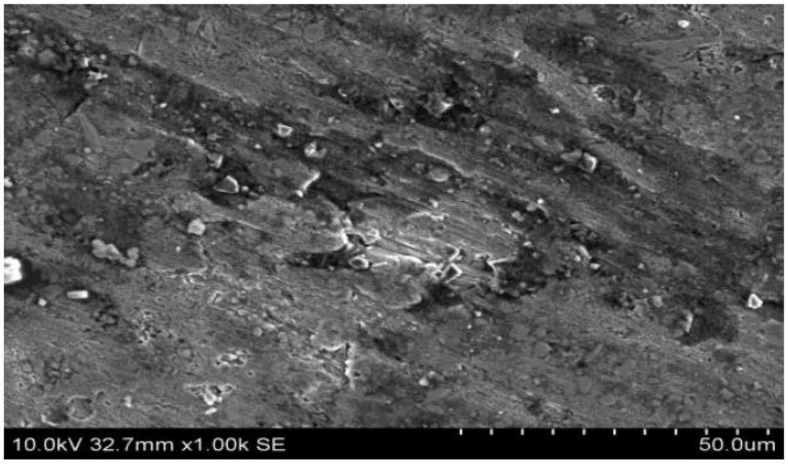

Figure 1 : Unmodified casting

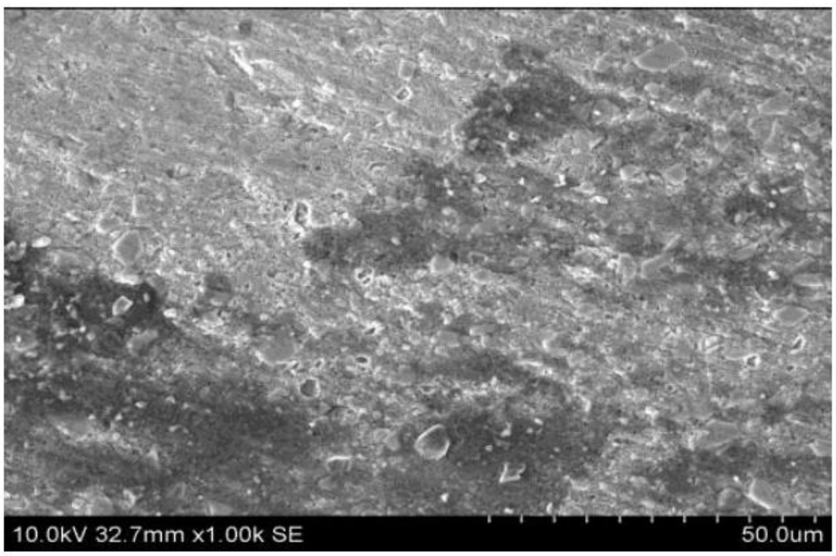

Figure 2: Microstructure alloy modified with Na

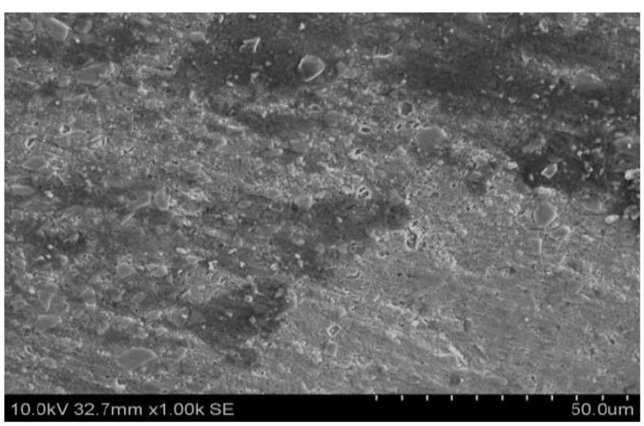

Figure 3: 1 min stirr casting

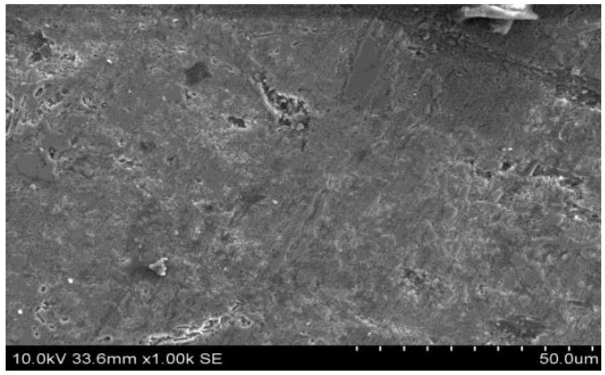

Figure 4: 2 min stir casted specimen

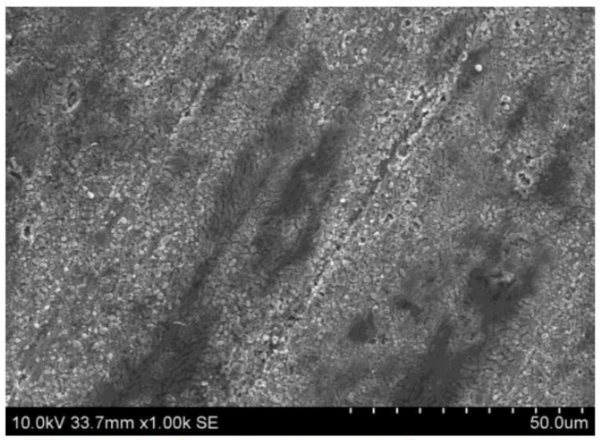

Figure 5: 4 min stir casted specimen

CONCLUSIONS

1. Modification treatment with sodium compound increases all properties such as UTS, toughness, hardness.
2. When stirring time increases the mechanical properties are also improved and finer grains are obtained.
3. Stirring time and speed of stirring also influence the mechanical properties of LM6 alloy
4. Microstructure analysis reveals that fibrous structure is predominant in modification and grain refinement is predominant in stirring.
5. Modification of metal with sodium improves hardness about 30%.
6. Modification of metal with sodium improves tensile strength about 60%.
7. Stirring time and speed of stirring variation will result in 25% - 40% increase in tensile strength

8. Stirring time and speed of stirring variation will result in 20% - 60% increase in hardness

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