STUDY OF IMPACT OF ADDITION ALLOYING ELEMENT IN ALUMINUM ALLOY: A REVIEW

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ABSTRACT: Recent 20th century, aluminum and aluminum alloys drastically used in automotive industries like automobile and aerospace locomotive industries because of its various mechanical properties like strength malleability and formability corrosion resistance, electrical and thermal conductivity good machinability. The microstructure of corresponding alloy and intermediate phase compounds during formation of corresponding alloy change the addition of alloying element which effect on mechanical properties. In present research paper shows the use of aluminum and aluminum alloys with containing other alloy elements, with their effects and micro structural behavior and wear behavior at various speed load condition.

Keywords - Aluminum alloy, aluminum- silicon alloy, aluminium- silicon-titanium alloy, cadmium in aluminum–silicon alloy, aluminum-silicon-titanium nitrate (TiN).

INTRODUCTION

Aluminum alloys are light weight, high corrosion resistance, high electrical, thermal conductivity, good malleability, formability, High machinability, workability. In Aluminum alloys create porosity gases during melting process, therefore in aluminum alloys fond some problems while casting such as relatively low strength, unstable mechanical properties. These properties include high specific strength, high wear and seizure resistance, high stiffness, better high temperature strength, controlled thermal expansion coefficient and improved damping capacity. The aluminum alloy microstructure and mechanical properties can be improved by alloying, cold working and heat treatment. The combination of mechanical, physical and tribological properties based on addition of alloy elements, like (Ti, Mg, Ce, Co, Na Ni, Sn) with their percentage while cold working and heat treatment [1]. Alloying elements are selected based on their effects and suitability.

LITERATURE REVIEW

Addition of other alloying element with silicon contained alloy finding of effect on mechanical property. A number of research paper has been studied which deals with the aluminum silicon based alloy for mechanical property.

Riyadh observed and identifies the effect of factor and condition for aluminum–silicon casting alloy of load and speed on sliding friction coefficient and performance are carried out by experimentally with different loads, speeds and with relative humidity.

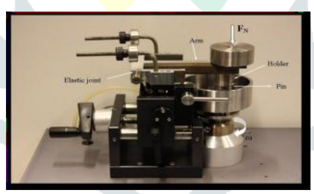

Fig. 1 Pin-on-Disc wear testing machine

Experiments carried out on Pin-on-Disc wear testing machine with loads (10, 20, and 30 N) and the speed (200, 300, and 400 r/min) and relative humidity of 70%. This shows that wear rate increases with increasing load and decreases with increasing of sliding distance for achieving stability also effect on friction coefficient before reaching on stable state , where increasing the sliding speed decrease the friction coefficient. The wear rate significantly increases when the load increases.

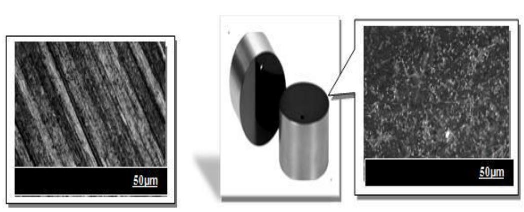

Fig. 2 Micrographs showing before and after wear surface load 10N& 400 rpm

On the other hand, small coefficient of friction values, together with increase in sliding speed, loading, and sliding over long distances, reduce wear rate. Thus, maintaining appropriate sliding speed and normal load levels can reduce frictional force and wear and improve the mechanical processes[5]. Increase load significantly increase wear rate, same as increasing in sliding loads speed and distance increase the small amount of coefficient of friction value. This will improve by only reducing of frictional force of sliding speed.

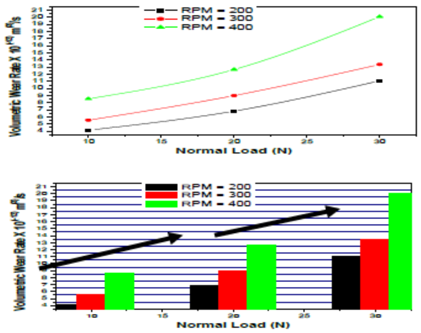

Fig. 3 several experiments were conducted to investigate the effect of normal load and sliding speed on the wear rate of the aluminum–silicon casting alloy. [2].

N. Saheb studied the Ti containing alloy improve the wear behavior of as-cast and heat-treated aluminium alloy, rapid cooling has been investigated in dry sliding using a pin-on-disk apparatus. Worn surfaces and wear debris were examined and analyzed by scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS), and X-ray diffraction (XRD).

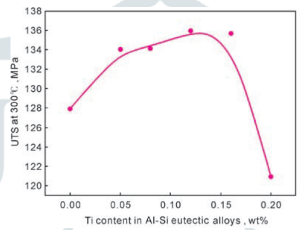

Fig. 4 The influence of Ti content on the UTS at 300 degree

However, these alloys displayed higher wear rates, and lower wear resistance. Increase Ti content in Al-Si alloy improved wear resistance of both as-cast and heat-treated alloys, as well as precipitation of the intermetallic compound Al3Ti phase. Which result of increase wear rate and improved their wear resistance [3].

Muna K. Abbass reviews the effect of wear behavior for addition of cadmium in aluminum–alloy (Al-12%Si) microstructure under dry sliding conditions. By using the Pin-On-Disc technique under the 5-20 N loads, at constant sliding speed and constant time. Different percentages of cadmium (1.0, 2.0, 3.0) wt% with Al-Si alloy which shows the Al-Si matrix decreases the wear rate and improves the wear properties.

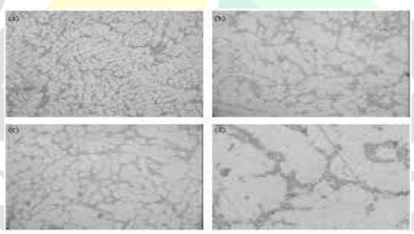

Fig. 5 Microstructure shows Al-Si particles in a matrix

Containing 3%Cd in aluminum–alloy (Al-12%Si) with 10N is the best alloy in wear resistance and friction coefficient. But reduces the friction coefficient and highest wear resistance at high loads (20N). The addition of cadmium at different ratios leads to an increase the wear resistance and mechanical properties. [4].

Francis Uchenna studied on dry sliding wear characteristics of Al-Si alloys. Where contain of Aluminum-silicon alloys 7%, 12% and 14% weight of silicon used for casting method. Al-Si alloy Micro structural characterization was performed by using optical microscope (OM) and scanning electron microscope (SEM).

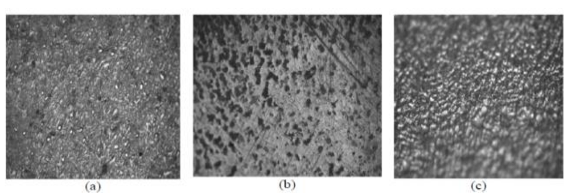

Fig. 6 Microstructure of as Cast alloys: (a) Al-7%Si (b) Al-12%Si and (c) Al-14%

Observing of various samples for Hardness and wear characteristics shown uniform behavior. But addition of silicon percentage increases the wear rate decreases. Wear rate also affected by increasing of load, speed and distance. As per their observation addition of 14% Si is superior other hand 7% and 12% Si eutectic silicon for various wear characteristics. [5].

M. Zeren stated that the addition of Ti with Al-Si cast alloy increase the hardness. Morphology of intermetallic particles in (Al–Si–*x*Ti) cast alloys with 0, 0? 1, 1, 2, and 5% Ti have been utilized for this purpose.

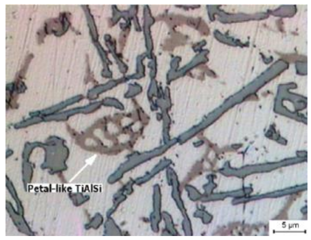

Fig. 7 Ti addition on the microstructure

Observations were made by optical microscope (OM) and a scanning electron microscope (SEM), pin on disc tribometer under dry sliding conditions. By increasing Ti content, hardness increases due to increasing volume fraction. They were conclude that Ti based intermetallics can have different morphologies (flakes and petals), which different chemical compositions depending on other alloying elements and cooling rate of the alloy.

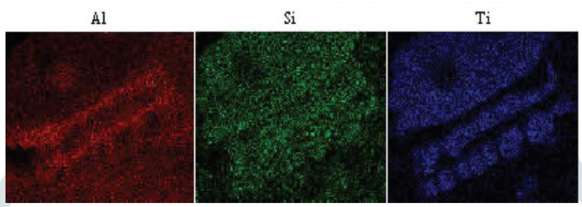

Fig. 8 Micrograph and EDX mapping analyse of particle on worn surface of Al–Si–5Ti alloy

The alloys have maximum 0?2% vanadium, Ti content up to 1% Ti can be modified to petal-like shapes, the wear resistance of the alloys which control the morphologies and growth properties of TiAlSi intermetallics. [6].

S.Srivastava studied that Using different amount of graphite with aluminum and silicon composite for pin on disc. Wear resistance increases with increasing load, speed, and no. of rotation. This paper Al-Sn alloys and Graphite was chosen as reinforcing element. The content of graphite varied from 1.6 to 8.4 wt%. Which not only improves the mechanical properties but also improve the tribological properties due to lubricating action. The Al-6.3%Sn-8.4%Gr composite showed higher percentage of elongation while compared to Al-6.3%Sn-1.6%Gr.

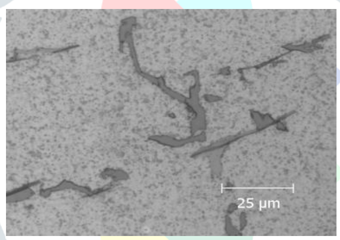

Fig. 9 Microstructure of Graphite

The experiment was commenced at different sliding distance, speed and using normal load. Where the testing time and SEM analysis to analyze the wear debris. Friction coefficient and wear volume have shown large sensitivity to the applied normal load and ductility of composite materials increase with graphite content in the matrix increasing wt%. And decrease the coefficient of friction. The varied content of graphite in aluminum alloy hardness is affected which effect reduce the mechanical resistance. At low loads and sliding velocities wear surface was covered with oxide layer smooth in nature, but at higher loads or sliding velocities surface is highly deformed with to larger wear rate. [7].

Anasyida S. Studied that the effect of wear behavior of as-cast Al-4Si-4Mg alloys with addition of 1 - 5 wt% cerium by a scanning electron microscope (SEM) equipped with an energy dispersive X-ray spectrometer (EDX). Dry sliding wear tests were carried with fixed sliding speed of 1 m/s and a range of load 10N, 30N, 50 N at room temperature (25^{o}C). the change of morphology and wear debris was found consistence with change in worn surface appearance.

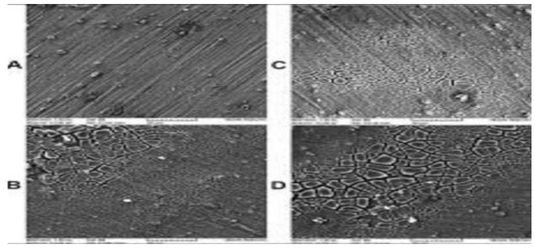

Fig. 10 SEM micrographs of steel samples coated at different immersion times in cerium chloride solution

The addition of intermetalic compound needle like shape Al-Ce and Al-Si – Ce phase. Increase the 5% wt of cerium which helps to improve wear resistance and lower the coefficient of friction of cast alloy formation of craters and severe localized plastic deformation also observed the worn surface of alloys which produces flakes wear debris and fine particulate [8].

Malek Ali studied those mechanical properties of Al–12% Si matrix reinforcement Addition various amount of titanium nitrate (TiN) particles shown near uniform distribution and hardness and wear resistance increased considerably in aluminum alloy.

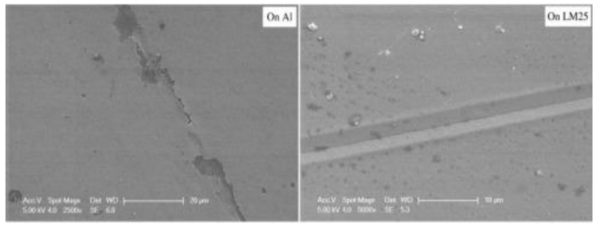

Fig. 11 Microstructure shows aluminum- silicon-titanium nitrate (TiN)

Increasing load and speed parameter on Pin on disc are observer, it improved wear resistance and increasing reinforcement percentage at different condition. Tin reinforcement sample have applied different load, which exhibited higher wear resistance than rest condition. where after addition of 15% TiN particles shows wear loss in average about 49.5 % with compared sample [9].

Amit Telang studied the effect of SiC particle reinforcement with heat treatment on Al alloy (ADC12) for application of automobile brake discs. the composite (ADC12) with silicon carbide (SiC) in weight percentage of 10% as with heat treated variety.

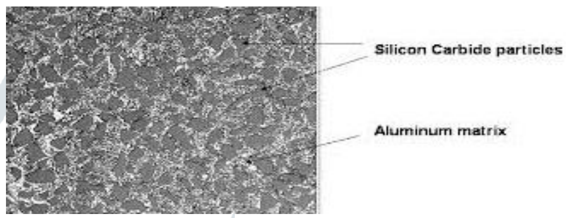

Fig. 12 Microstructure of Al-Si (Silicon Carbide) Composite.

He observed that The brake torque of the composites is higher than steel, which addition of SiC particles increased material hardness and brake torque. So brake torque for ADC12 alloy at all velocities and brake force is lower than steel. The average brake torque for ADC 12-10 SiC is 14.3% better than steel whereas ADC 12-10 SiC (HT) gives 54 % higher value than steel for the tested brake force. Evaluate performance of the disc brakes accurately before the brakes are put in actual operation. The coefficient of friction of ADC 12 is inferior by 40.5% on an average to the steel for the velocities of brake torque. The facility helps in comparative analysis of the different brakes material in the simulated condition which helps in selection of right material for a wide range of input parameter values. [10].

CONCLUSION

Aluminum silicon alloy used in various industrial applications because of its stability and good mechanical as well as casting properties. The following conclusion as follow

1. The value of strength, hardness, wear resistance, coefficient of friction get affect, values may be increase or decrease.
2. Increase in silicon percentage was decreases in wear rates.
3. Increase in load, speed is shows the wear behavior in nature.
4. Significantly change in structure were observed in aluminium silicon alloy
5. Variation of friction and wear rate depends upon various interfacial properties.

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