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Study of Optical Microscopy and Wear Behaviour of T6 Treated Al16Mg_2Si2Cu2Ni Alloy

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Abstract
In this work, a study of optical microscopy and wear behaviour of as cast aluminium Al16Mg_2Si2Cu2Ni alloy, has been forged and homogenized for 5hr with T6 Heat treatment. In this study we have come across various parameters like Friction force, Friction co-efficient, Speed and Volumetric wear rate and their relationship. It is observed that the Friction force and the volumetric wear rate are high at low sliding speed and reduce with increase in sliding speed. Whereas the interface temperature is low at low sliding speed and increases with the sliding speed. Results of SEM structure show rounded corners of Mg_2Si intermetallic blocks embedded with Ni in it due to the effect of 5 hour homogenizing.
Keywords*:* flow stress, plastic deformation,precipitates and friction coefficient.

1.0 Introduction

Aluminium alloyed with silicon (Si) is the material of tremendous industrial importance. The Al-Si alloys have a number of favorable characteristics including good wear resistance, low thermal expansion, ease of weld-ability, increase in the strength and stiffness without increasing the density. Various casting processes including high pressure die casting, permanent mold casting, sand casting and many other processes exhibit excellent productivity, mechanical and physical properties in these alloys. The strength and quality of Al-Si alloy castings are determined by the appropriateness of their microstructure, viz., the fineness, size and morphologies of the micro-constituents present there-in, as well as the amount of porosity produced in the casting.

2.0 Experimental Details

2.1 Material selection

In the present investigation, the hypereutectic alloys such as Al-25Mg_2Si with Cu, Mg and Ni as alloying additions are used to represent the light weight heat treatable Al-Mg_2Si-Cu alloys. Table 2.1 summarizes the nominal compositions of all the selected alloys. The as-cast ingots of different compositions, listed in the Table 2.1, are obtained from FENFE Metallurgical, Bangalore, India. The chemical composition of all the alloys is anlalysed by spark emission spectrometer. The alloy used in the present work is Al16Mg2Si2Cu2.5Ni its chemical composition as shown in the Table 3.1.

Table 2.1 Chemical composition (wt %) of Al16Mg2Si2Cu2.5Ni alloys

Sr. No.	Alloy %	%Si	% Ni	%Cu	%Mg	%Al
1.	Al16Mg_2Si2Cu2.5Ni	4.51	2.34	1.8	12.2	73.35

3. Methodology

Sample preparation

Ingots of the alloy are cut into small pieces and machined to required dimensions. Samples are prepared for metallographic examination by polishing, using polish papers of grade 4/0, 6/0, 8/0 and then wet polishing is carried out on polishing machine using wet alumina paste of sub-micron grade. Specimens are etched with Keller's reagent and analyzed under optical microscope interfaced with image analyzer.

4.0 Results and Discussions

4.1 Micro structural results (1hour homogenized)

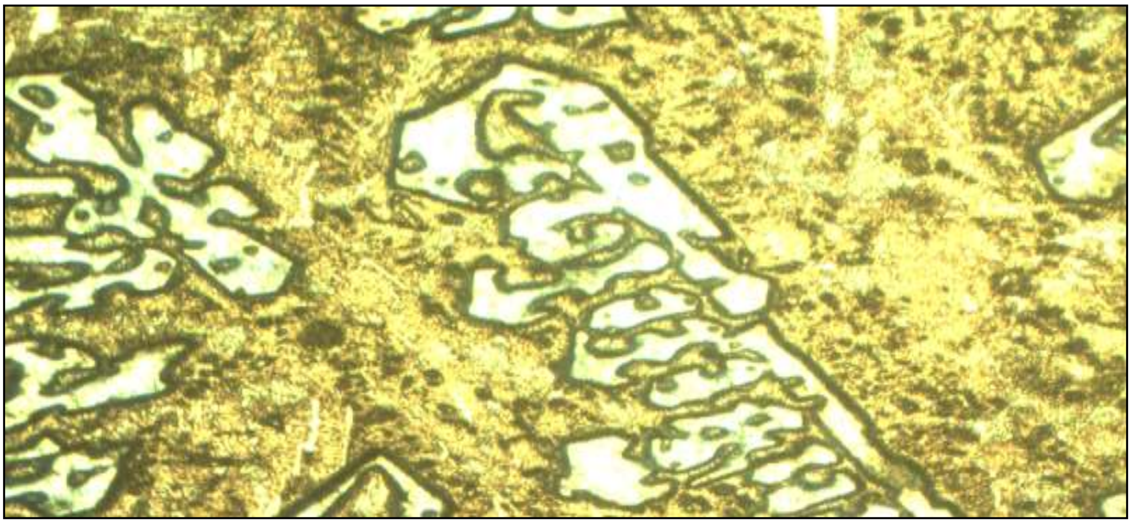

Fig 4.1 Al16Mg2Si2Cu2.5Ni alloy forged homogenized for 1 hour

Results & Discussions:

- Chinese script like structure of Mg_2Si is seen.
- Plates of Ni get converted into dispersed structure distributed uniformly in the Aluminum matrix.

4.2 SEM microstructure results(1 hour homogenized)

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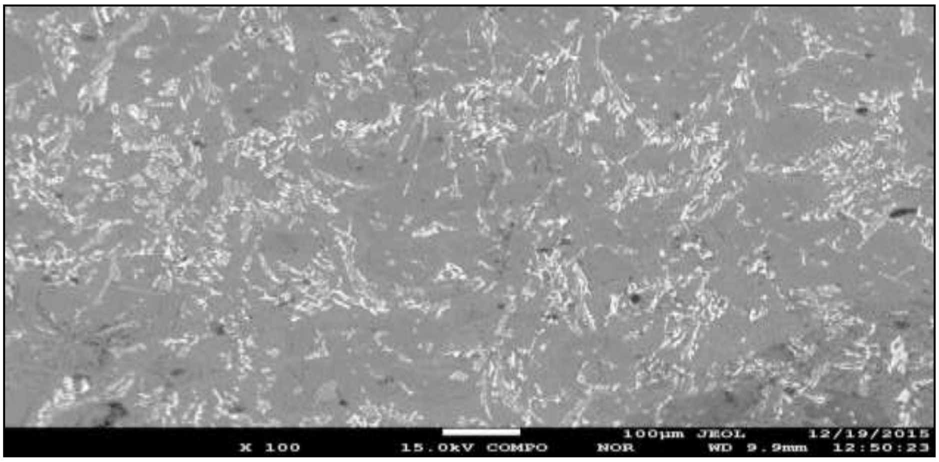

Fig 4.2 SEM microstructure results (1 hour homogenized)

4.3 Graphs

4.3.1 Speed v/s Friction coefficient

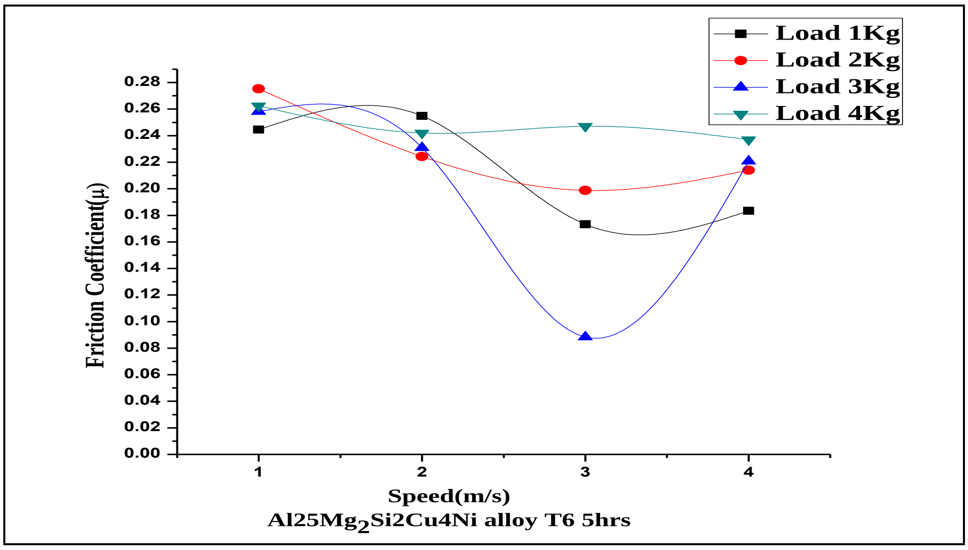

Fig. 4.1 Speed vs Friction coefficient

Result:

a. Load 1Kg: Between 1m/s -2m/s of speed the friction coefficient slightly increases and falls down as speed increases.

b. Load 2Kg: As the speed increases friction coefficient gradually decreases.

c. Load 3Kg: Between 1m/s -2m/s of speed the friction coefficient slightly decreases and from 2m/s-3m/s of speed friction coefficient suddenly decreases then suddenly increases for higher speed.

d. Load 4Kg: As speed increases friction coefficient almost remains constant.

Discussion: For all loads friction coefficient values remain high at low sliding speed. However with increase in the sliding speed coefficient of friction values go on decreasing, beyond this sliding speed friction coefficient values become stable and non-variant.

4.3.2 Speed v/s Friction Force

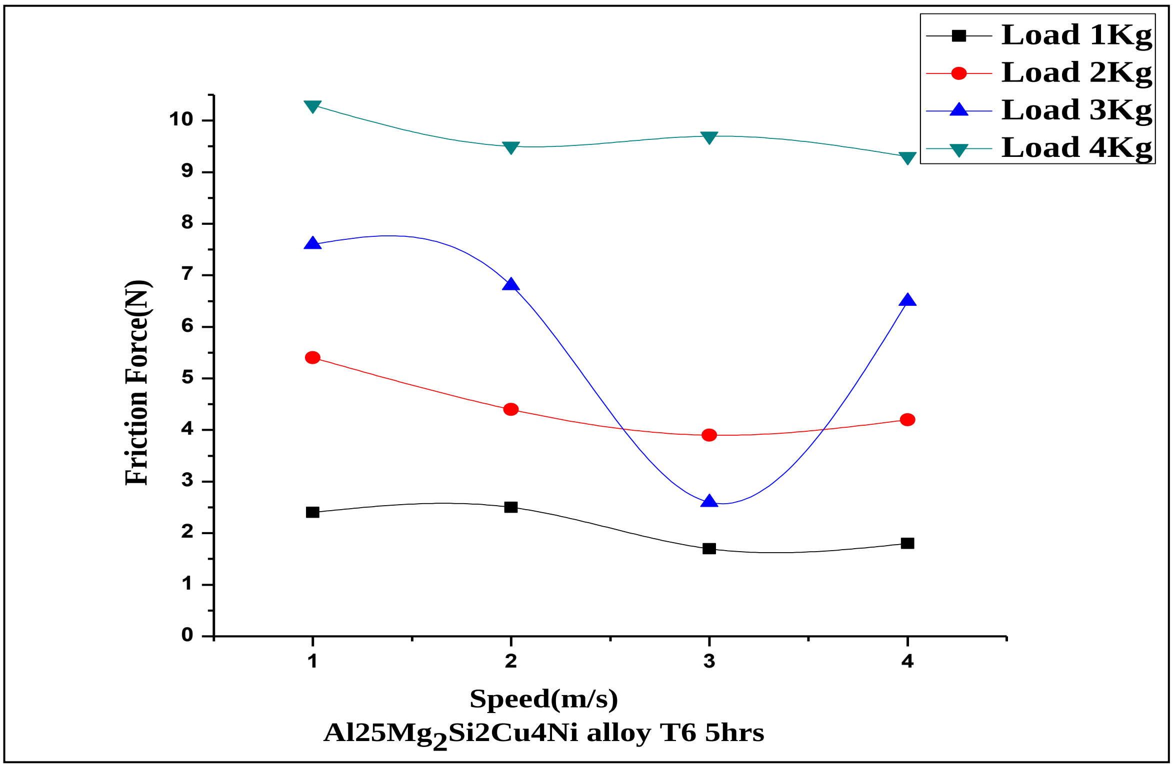

Fig. 4.2 Speed v/s Friction Force

Result:

a. Load 1Kg: As the speed increases the friction force increases and for higher speed it slightly decreases.

b. Load 2Kg: As the speed increases friction force gradually decreases.

c. Load 3Kg: Between 1m/s-3m/s of speed friction force rapidly decreases and suddenly increases for higher speed.

d. Load 4Kg: As speed increases friction force almost remains constant.

Discussion: As seen from graph friction force values are low at low load of 1kg and higher for higher loads i.e. 2, 3 and 4 kg respectively. With increase in the sliding speed friction force values decreases and becomes stable after 3m/s sliding speed is reached.

4.3.3 Speed v/s temperature

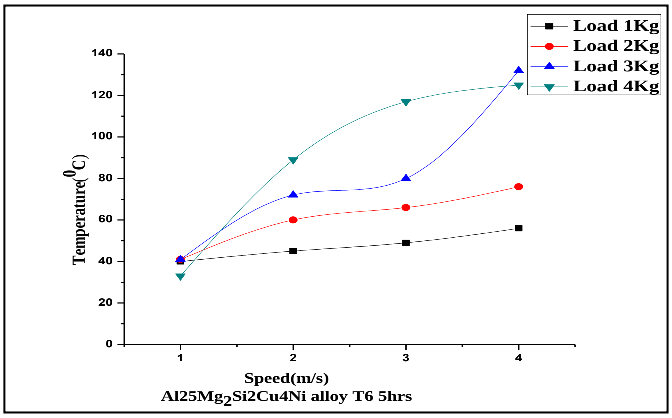

Fig. 4.3 Speed v/s temperature

Result:

a. Load 1Kg: As the speed increases temperature slightly increases.

b. Load 2Kg: As the speed increases temperature gradually increases.

c. Load 3Kg: Between 1m/s-3m/s of speed the temperature gradually increases then suddenly increases.

d. Load 4Kg: As the speed increases temperature exponentially increases.

Discussion: As seen from graph interface temperature is less at low sliding speed and goes on increasing with increase in sliding speed. Thus we may conclude that the interface temperature is a function of sliding speed, i.e. temperature is directly proportional to sliding speed.

4.3.4 Speed v/s Volumetric Wear Rate

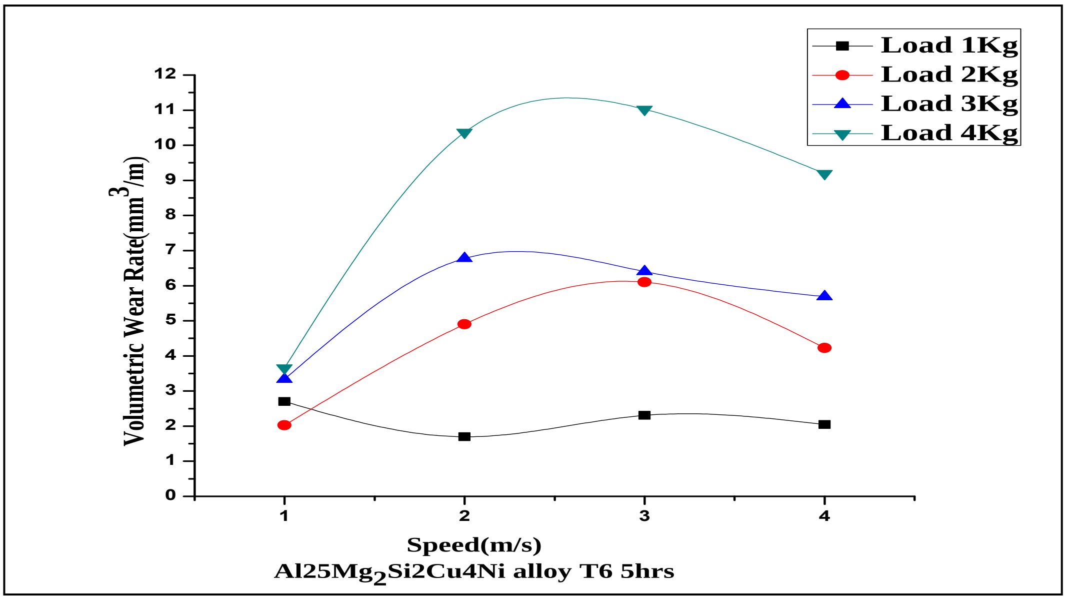

Fig. 4.4 Speed v/s Volumetric Wear Rate

Result:

a. Load 1Kg: As the speed increases the volumetric wear rate changes slightly.

b. Load 2Kg: Between 1m/s -3m/s of speed the volumetric wear rate increases exponentially then it decreases.

c. Load 3Kg: As the speed increases volumetric wear rate gradually increases.

d. Load 4Kg: Between 1m/s-3m/s of speed volumetric wear rate increases rapidly then it falls down.

Discussion: As seen from graph for load 1kg the volumetric wear rate remains constant for increase in speed. But as load increases volumetric wear rate increases for low sliding speed. But as the sliding speed reaches maximum value the volumetric wear rate start decreasing.

5. Conclusions

1. As the sliding speed increases the friction coefficient decreases for constant load.
2. We can conclude by saying that sliding speed and Friction Force are inversely proportional to each other.
3. As the speed increases temperature increases for constant load.
4. As Speed increases Volumetric Wear Rate increases at constant Load.

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