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STUDIES ON Al7075 AND SiC METAL MATRIX COMPOSITES

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Abstract - *Development of Aluminum steel Matrix Composites (AMMCs) with stepped forward tribological assets has been one of the principal necessities inside the area of material technological know-how and technology. Nowadays, Aluminum 7075 alloy with Silicon Carbide (SiC) as reinforcement is changing the existing additives which can be synthetic with Aluminum oxide reinforcement because of their better wear resistance and creep resistance applications. As we recognize that in production sectors gears play a vital role in transmitting energy from one shaft to every other shaft, therefore the existing work focused on producing of equipment with AMMC fabric using stir technique. The various assessments were performed on AMMC material to know the various hones (Tensile strength and hardness) and it became located that there's a boom in energy and hardness through 10 percentage as compared to Al6061. From Micro structure analysis performed it clearly shows that uniform distribution of SiC particles within the metallic matrix system. The overall performance takes a look at was performed at the synthetic gear to research wear resistance of the matrix cloth. Stir casting method used inside the matrix training is satisfactory not pricey technique to produce the matrix. Al 7075-SiC matrix has been selected for the manufacture since it has ability programs in aircraft and space industries due to higher power to weight ratio, excessive wear resistance and creep resistance.*

Key Words: **7075Al alloy, SiCp, Composite, Fabrication, AMMCs, Stir Casting, Micro analysis,**

1. INTRODUCTION

A composite material is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined produce a material with characteristics different from the individual components.

[4] Silicon carbide particles (SiCp)-reinforced metal–matrix composites (MMCs) have been considered as an excellent structural materials in the aeronautic–aerospace transport, the automotive industry, because of their excellent combination of low density and high thermal conductivity. The key to their property improvement lies in the structure, chemistry and the nature of bonding of aluminium (Al)–silicon carbide (SiC) interfaces. Metal–matrix composites are conventionally fabricated using different techniques such as power metallurgy, squeeze casting, and the stir casting. Stir casting is cost effective. Powder metallurgy is expensive. An inherent difficulty encountered in the fabrication of SiC–Al alloy composites is that the molten Al alloys normally do not wet considerably the ceramic reinforcements. It is well known that the SiC reinforcements tend to react with aluminum during processing, leading to the formation of Al4C3 and Si at the interface. Efforts have been directed to prevent the chemical reaction at interfaces by oxidation of SiC, coating of SiCp, or alloying of Al matrix with Mg or Si. Further efforts are needed to fabricate AA7075/SiC composites, where SiCp are uniformly distributed in 7075 Al alloy matrix and there are no chemical reactions at the interface. Characterization of AA7075/SiC composites by various techniques is needed to ascertain the proper microstructure, identification, distribution and weight percentage of different element in 7075 Al alloy. It is also necessary to know if there are any adverse chemical reactions during fabrication.

2. LITERATURE SURVEY

1. **RK Bushan** observed the study of Al–8.7 wt. % Mg matrix alloy reinforced with SiCp was investigated. The SiC was added as dispersed particles by Vortex method. Better distribution of SiCp was obtained in matrix. The as-cast microstructures, the evolution of the microstructures during reheating, and the mechanical properties of thixoformed products of 7075 Al alloy cast by liquidus semi continuous casting(LSC)were studied .The melt was held for 30 min at the temperature (638 °C) closely near its liquidus temperature ,and then it was cast semi-continuously. A microstructure of fine, uniform and net-globular grains was obtained, which was satisfactory for meeting the microstructural requirement of thixoforming. Decreasing first cooling and the casting velocity and increasing second cooling were propitious to the formation of the fine, uniform, and net globular grains. The formation of the net-globular grains was resulted from the increase in the number of crystal nuclei and the decrease in growth velocity of grains during LSC. The net globular and rosette-shaped grains obtained by LSC became spheroids during reheating.

   Al matrix composites reinforced with unoxidized or oxidized SiCp and varying Mg concentrations were prepared using stir casting technique. The extent of interfacial reactions and composition of the reaction products, formed at the Al–SiC interfaces in as-cast form, and after heat treatments at 620 or 652 °C for 4 or 20 h, were studied on the surfaces of bulk samples, and those of the SiCp extracted from the composite by electro-chemical leaching. Alloying of Al matrix with 0.5 or 1 wt.% Mg and its segregation at the interfaces has been found to be effective in restricting the formation of the Al4C3 at the interfaces during casting.

The effect of SiC volume fraction and particle size on the fatigue behaviour of 2080 Al was investigated. Matrix microstructure in the composite and the unreinforced alloy was held relatively constant by the introduction of a deformation stage prior to aging. It was found that increasing volume fraction and decreasing particle size resulted in an increase in fatigue resistance reinforced with 10, 20, and 30 pct SiCp.

2. **Pradeep R et.al** observed the study of mechanical properties of Al and Silicon Carbide Metal Matrix Composite (MMC) of Aluminium alloy of grade 7075 with addition of varying SiC weight percentage such as 6%, 4%, 2%. The experimental result reveals that the combination of a matrix material improves mechanical properties like tensile strength, compressive strength, hardness and yield strength.

3. **H. Izadi et.al** investigated through FSP and has observed improvement in the micro hardness of Al–SiC composites produced by traditional powder metallurgy and sintering methods. The material flow in the stir zone during FSP was successful in uniformly distributing the SiC particles. However, when samples with 16% SiC (by volume) were processed, there were residual pores and lack of consolidation. An increase in hardness of all samples was observed after friction stir processing which was attributed to the improvement in particle distribution and elimination of porosity.

3. METHODOLOGY

- Clean the crucible.
- Crucible is coated by the graphite or ceramic powder.
- Set the furnace temperature 0°C to 750°C temperature.
- Pre heat the reinforcement at 0°C to 500°C temperature.
- Stirrer coated by the ceramic and graphite.
- Stirrer duration and speed 0 to 500 rpm.
- Duration of the stirrer is 0 to 10 mins.
- Scum powder is added to remove the slag and flux.
- Degasing tablets [exocrothene], it is used to remove the gas.
- Mould box is pre heated by the gas heater.
- Mould box is made by mild steel.

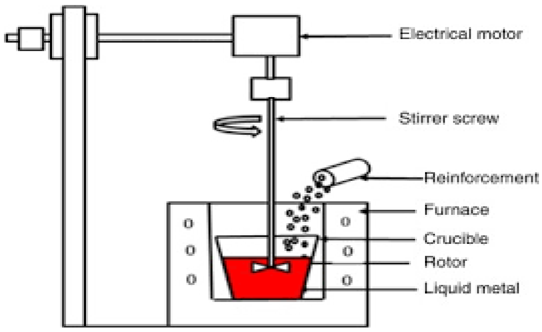


Fig-1 Stir casting procedure for Al7075/SiC MMCs

The stir casting experimental setup used for fabricating Al-SiC MMC is shown in fig-1. It consists of furnace for heating the metal, Stirrer and motor for mixing of debris. To start with, the SiC particles are preheated in a separate muffle furnace at 900 °C for 2h that allows you to do away with the volatile substances and impurities present and to preserve the particle temperature toward melting factor of aluminum alloy. The preheating of SiC debris results in the synthetic oxidation of the particle floor forming SiO_2 layer.

This SiO_2 layer enables in enhancing the wettability of the particle. Thereafter, Al7075 billets were charged into the furnace and melting became allowed to development till a uniform temperature of 750°C became attained. The flux is brought to Al alloy throughout melting to prevent oxidation of the aluminum. The soften became then allowed to cool to 600°C (slightly underneath the liquidus temperature) to a semisolid state and silicon carbide preheated combination changed into introduced to the soften in fragments and manual stirring of the slurry became carried out. Thereafter, small quantity of Mg less than 1% of the entire weight is introduced to improve the wettability between the reinforcement and the alloy. After performing 5 min of guide stirring, rest quantity of SiC is introduced alongside the hexachloroethane capsules for degassing the molten steel and to save you porosity inside the solid composites. After the guide stirring, the composite slurry become reheated and maintained at a temperature of 750°C±10°C and then mechanical stirring changed into accomplished. The stirring operation was carried out for 10 minutes at a common stirring rate of 500 rpm.

Table 1: Composition of samples.

Sample No.	Aluminum (Grams)	Sic (Grams)	Remarks
1.	2000	0	Al – 0% SiC
2.	2000	60	Al – 3% SiC
3.	2000	120	Al – 6% SiC
4.	2000	180	Al – 9% SiC

4. RESULT AND DISCUSSION

Microstructural analysis

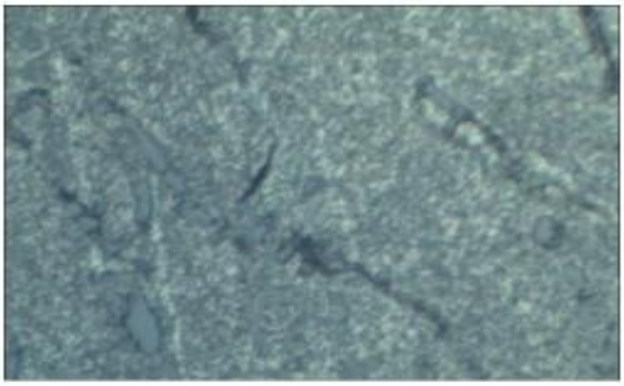
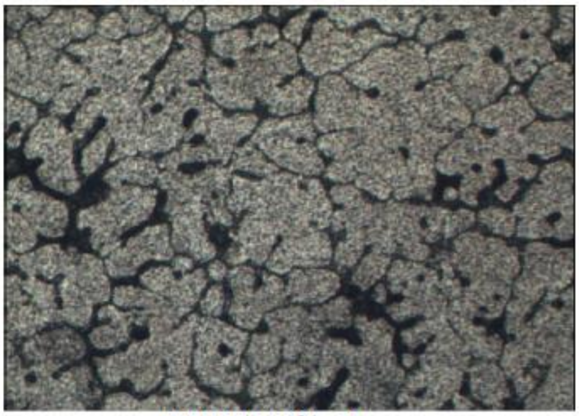
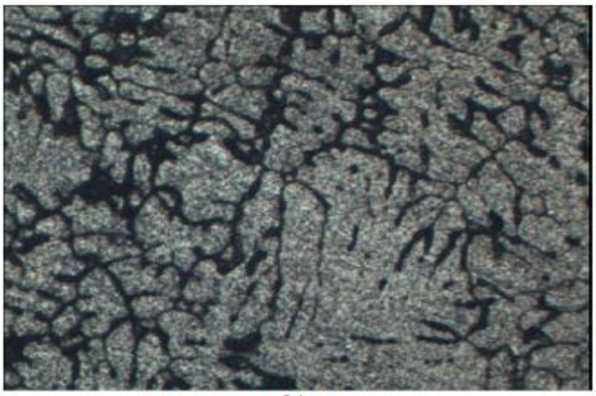


Fig-2 Al7075- 0%SiC



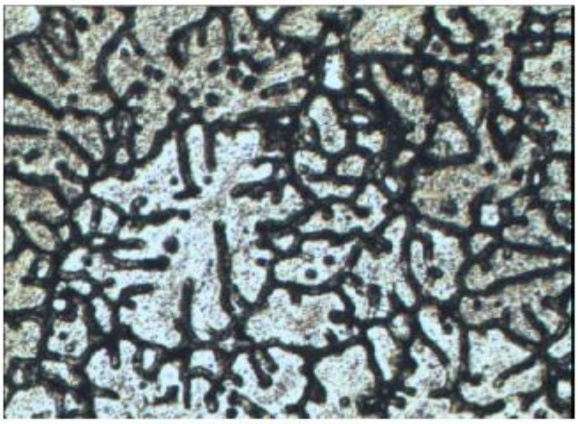
AL7075+3% Sic

Fig-3 Al7075- 3%SiC



AL7075+6% Sic

Fig-4 Al7075- 6%SiC



AL7075+9% Sic

Fig-5 Al7075- 9%SiC

The microstructural research of the stir casted Al7075-0%SiC, Al7075-3%SiC, Al7075-6%SiC and Al7075-9%SiC MMC has been furnished with the aid of optical microscope. The Optical microstructures are shown in fig 2-5. The optical micrographs of the as-forged composite discovered that the agglomerations of SiC debris are uniformly distributed in the matrix. It's far obvious from the microstructure that the distributions of reinforcement debris turn out to be extra uniform within the matrix as their weight percentage will increase.

Tensile Testing

Tensile testing was carried on Universal testing machine and the results are as under: Table 1-4 shows the % elongation, yield strength at 0.2% and UTS of Al7075-0%SiC, Al7075 -3%SiC, Al7075-6%SiC and Al7075-9%SiC. It has been concluded that the % elongation decreases with increase in SiC %.But yield strength and UTS decreases up to 10% SiC and then increases.

Table 1: Tensile result (Al7075- 0%SiC)

TESTS	RESULTS
Initial Area mm2	64.32
Initial gauge length mm	45.00
Final Gauge Length mm	50.36
Yield Strength MPa	199.79
Ultimate Tensile Load KN	15.01
Ultimate Tensile Strength MPa	233.45
% Elongation	11.91

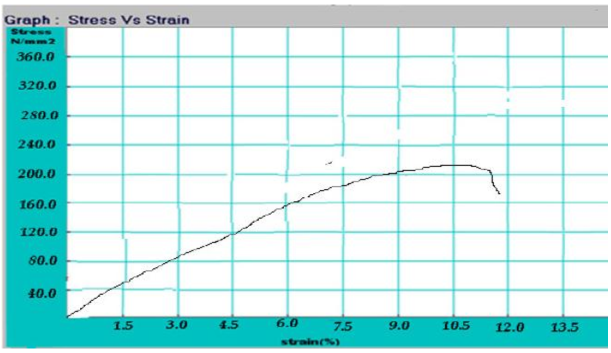


Chart-1 Al7075- 0%SiC

Table 2: Tensile result (Al7075- 3%SiC)

TESTS	RESULTS
Initial Area mm2	64.32
Initial gauge length mm	45.00
Final Gauge Length mm	50.87
Yield Strength MPa	158.9
Ultimate Tensile Load KN	13.10
Ultimate Tensile Strength MPa	203.08
% Elongation	13.04

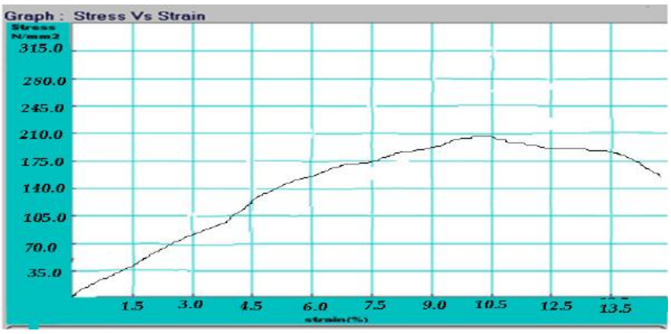


Chart-2 Al7075- 3%SiC

Table 3: Tensile result (Al7075- 6%SiC)

TESTS	RESULTS
Initial Area mm2	65.71
Initial gauge length mm	45.00
Final Gauge Length mm	50.64
Yield Strength MPa	175.1
Ultimate Tensile Load KN	16.47
Ultimate Tensile Strength MPa	245.8
% Elongation	12.53

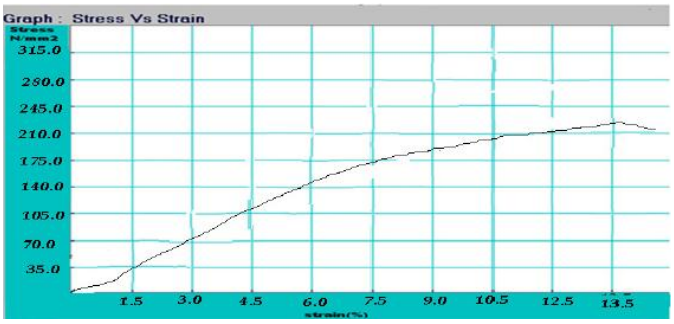


Chart-3 Al7075- 6%SiC

Table 4: Tensile result (Al7075- 9%SiC)

TESTS	RESULTS
Initial Area mm2	65.84
Initial gauge length mm	45.00
Final Gauge Length mm	49.67
Yield Strength MPa	250.4
Ultimate Tensile Load KN	19.64
Ultimate Tensile Strength MPa	298.3
% Elongation	10.37

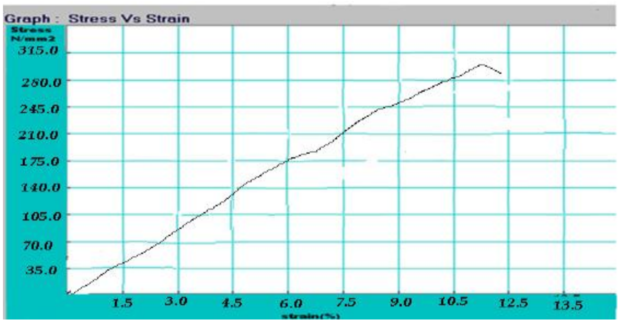


Chart-4 Al7075- 9%SiC

HARDNESS TEST

Hardness test was carried on and the results are as under: Table 5 shows hardness of Al7075-0%SiC, Al7075 - 3%SiC, Al7075-6%SiC and Al7075-9%SiC.

Table 5: Hardness test result

Sl no	Particulars of sample Al7075-SiC	Result 1	Result 2	Result 3	average
01	3%	67.1	65.3	64.2	65.5
02	6%	74.6	75.8	76.3	75.5
03	9%	87.3	88.4	86.1	87.2

CONCLUSION

[3] Al-SiC MMC had been efficiently fabricated by means of Stir casting. Stirring the MMC slurry in semi-stable country allows to incorporate ceramic particles into the alloy matrix. The settling of silicon carbide debris resisted due to stirring in semisolid state because of entrapment of silicon carbide particles between the dendrite arms. Processing variables such as retaining temperature, stirring speed, length of the impeller, and the placement of the impeller inside the melt are a few of the important elements to be taken into consideration within the production of solid metal matrix composites as those have an impact on mechanical properties. The microstructural research and results monitor the uniform distribution of SiC debris in to Al matrix. It is very hard to obtain the exact percentage of SiC, however it has been efficiently done with the aid of adopting appropriate system parameters. The trying out of composites have been carried out numerous times and then as a consequence parameters are varied to achieve the homogeneous and uniform distribution of reinforcement. The addition of silicon carbide debris to the matrix alloy improves the mechanical properties inclusive of hardness and tensile power of the matrix alloy. However the put on rate has a tendency to decrease with growing debris wt. percentage from 3% to 9%, which confirms that silicon carbide is beneficial for lowering the damage rate of MMCs. This material can be used at high improved temperature balance.

REFERENCES

[1] Acilar M, Gul F (2004) Effect of the applied load, sliding distance and oxidation on the dry sliding wear behaviour of Al–10 Si/SiCp composites produced by vacuum infiltration technique. Mater Des 25:209–217.
[2] Dong J, Cui JZ, Le QC, Lu GM (2003) Liquidus semi-continuous casting, reheating and thixoforming of a wrought aluminum alloy 7075. Mater Sci Eng, A 345:234–242
[3] Rajesh Agnihotri* and Santosh Dagar University Institute of Engineering and Technology, India "Mechanical Properties of Al-SiC Metal Matrix Composites Fabricated by Stir Casting Route"
[4] Hashim J, Looney L, Hashmi MSJ (1999) Metal matrix composites: production by the stir casting method. Journal of Materials Processing Technology 92-93: 1-7.
[5] Sarkar smarajit (2010) Some studies on aluminium matrix in-situ composites produced by chemical reaction.
[6] Rajesh Kumar Bhushan & Sudhir Kumar & S. Das fabrication and characterization of 7075 al alloy reinforced with sic particulatesReceived: 24 February 2011 / Accepted: 23 April 2012 / Published online: 5 May 2012 # Springer-Verlag London Limited 2012