Mechanical properties of Al-6061 reinforced with SiC-Gr hybrid composites

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ABSTRACT- The demand for light weight and high strength, advanced materials is increasing in automobile, aerospace and marine industries. The present work focuses on microstructure and the mechanical properties of uncoated & coated SiC reinforced Al-6061 hybrid composites produced by stir casting method. The stir casting technique is most popular to be used for preparation of composites with dispersoid reinforced in metal matrix from last few decades. The major challenging task is the uniform distribution of hard reinforcement SiC and soft reinforcement Gr into molten metal. The quantity of incorporation of reinforcement in to metal matrix is varied by weight percentages of 5% & 10% where as the weight percentage of soft reinforcement kept as1Wt% constant. Major aim of this work is to develop a high quality cast HMMC with less defects, using reinforcement. Results analyzed that the increase in content of SiC in to metal matrix alloy increase various mechanical properties of SiC reinforced hybrid composites. Hence when compared to base alloy, the aluminum hybrid composites exhibits improved properties.

Keywords: Al-6061, SiC, Gr, dispersoid, stir castings, reinforcement

1. INTRODUCTION

Aluminum metal matrix composites are the best suited materials for wear and structural applications due to their low density, light weight and ease of fabrication for composites [1]. The aluminum based metal matrix composites is comprehending itself to the new class of advanced materials in this two decades and it enhances the elastic properties of metal matrix. Composites are strongly influenced by micro structural parameters of the reinforcement such as shape, size, orientation, distribution and volume fraction[2]. The incorporation of ceramic material in to metal has developed a new class of material as composites which exhibited a better property compared to monolithic alloys and when the incorporation of two composites is done, which result in the development of new class of material as hybrid materials. There is an increasing demand for advanced materials with light weight, high strength and high ductile in the field of Aerospace, automobile and aviation industries.

The one of the best method which is boon to produce complex shaped components is casting. Stir casting is one of the most appreciated method to manufacture dispersoid reinforced metal matrix composites , which produce most accurate component required as per the need of customer requirement in a simple manner, the cost effective one. The major problem of the stir casting process is the proper distribution of reinforcement in to molten metal and to get a homogenous dispersion of the ceramics particles [3]. In the spot of above discussion, the present work focuses on microstructure and mechanical properties of uncoated and copper coated SiC reinforced Al6061 hybrid composite developed by stir casting method.

2. PREPARATION OF COMPOSITES

The chemical composition of Al6061 alloy is discussed in the table below , Aluminium is used as matrix here. The reinforcements added to this matrix are of two types, one being hard in nature and the other being soft in nature. The hard reinforcement used in this work is silicon carbide whose size ranges from 5-30 µm and which is subjected to electroless copper coating. The soft reinforcement used in this work is graphite which will be in powder form. Initially a batch of Al6061 is taken in a crucible and heated with high voltage supply in an electric muffle furnace, till the alloy melts and reaches a temperature of around 750°C. The same procedure is repeated for 5Wt% and 10Wt% SiC (Copper coated and uncoated) with constant 1Wt% Gr. In the mean time reinforcements are subjected to the sintering process

for time period of around of 60 minutes at 500°C temperature. The degassing tablets are added in order to entrap all the gases and slag is removed in the form of wastage. The moltenmetal is stirred with the help of mechanical stirrer with the speed of about 200 RPM for time period of 10 minutes and the sintered reinforcement are added simultaneously, the hard reinforcement are added in scale of varying weight percentages of 5%-10% where as the weight percentages is kept constant for soft reinforcement. The above procedure is similarly applied to the copper coated SiC and uncoated SiC added to molten metal matrix. Once the addition of reinforcement is done the hybrid is transferred in to pre-heated cast iron dies and finally it is allowed for solidification.

Contents	Quantity in %Wt
Si	0.4-0.8
Fe	0-0.10
Cu	0.15-0.40
Mn	0-0.15
Mg	0.8-1.2
Cr	0.4-0.35
Zn	0-0.25
Ti	0-0.15
Al	95.85-98.56

Table-1 Gives the details of chemical composition of Al6061 matrix alloy

The solidified form of HMMC is subjected to machining action and the specimen for microstructure micro-hardness and the tensile test are prepared as per ASTM standards.

2a

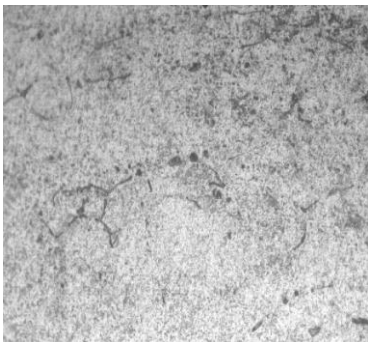
2b

2c

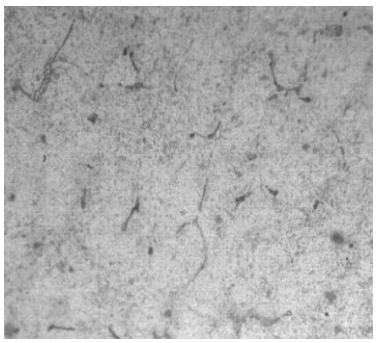
Figure- (a) shows mechanical stirrer with electric furnace (b) molten metal pouring (c) solidified HMMC

3. Results and discussion

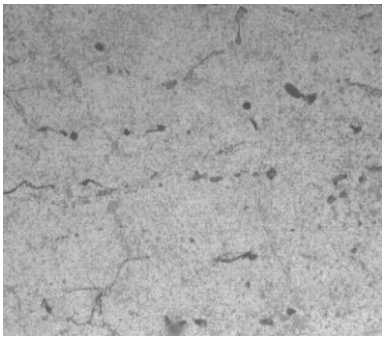
3.1 Microstructure



3a



3b



3c

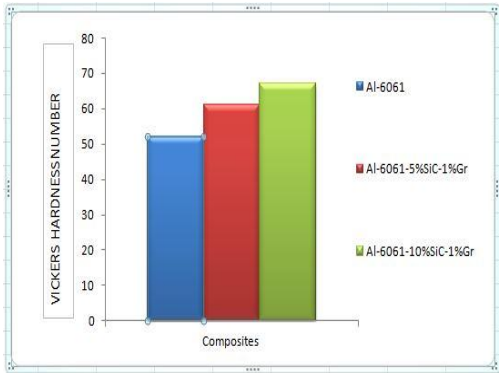
Figure-3a, 3b and 3c shows the microstructure of Al6061, Al6061-5wt%SiC-1wt%Gr & Al6061-10wt%SiC-1wt%Gr.

It is clear from the above figures that the distribution of silicon carbide and graphite particles are fairly homogenously distributed. Agglomeration of reinforced phase is seen in some hybrid composites with higher percentages of SiC reinforcement. From the figure 3a , it is clear that the microstructure of Al-6061 consists of fine intermetallic precipitates in a matrix of aluminium solid solution, eutectic melting is not seen and segregation or porosity was not seen in the section.

The figure 3b, shows the microstructure of Al6061-5wt%SiC-1wt% Gr. It consist of fine intermetallic precipitates in a matrix of aluminum solid solution with homogenous distribution of reinforcement and the porosity is not observed in the section. Refinement is also seen.

The figure 3c, shows the microstructure of Al6061-10wt%SiC-1wt% Gr. Here it is clear that the reinforcement added get distributed as a single phase with matrix element.

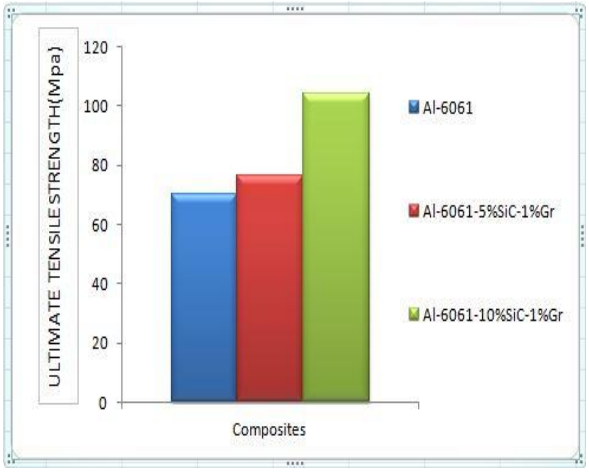
3.2 Hardness



3d

From the above graph figure (3d) it is clear that the resistance ability of a composites against hard impingement increases with the increase in content of SiC Wt% and on the other hand we can also see that hardness number increases with higher content of SiC. The composition with 10 wt% SiC shows an improvement of 35% in hardness and where as with constant 1 wt% of graphite helps composites to develop better wear property.

3.3 Tensile Strength



3e

From the above figure (3e) it is clear that tensile strength of the developed new class of Al-6061 hybrid composite increases with the increase in content of Wt% of SiC reinforcement. There is linear improvement in the strength of Al-6061-5Wt%SiC-1Wt%Gr compared to the base alloy but there is drastic improvement in the strength of Al6061-10Wt%SiC-1Wt%Gr hybrid composite with 20-25% increase in the tensile strength.

4 Conclusion

Finally it is concluded that the developed new class of Al6061 hybrid composites exhibits the satisfactory property both in case of hardness and tensile strength. The developed hybrid composite shows uniform distribution of reinforcement in it. This can be observed from microstructure of developed hybrid composites.

5. Reference

1. Y.Sahin and M. Acilar, Composites Part A 34 (2003), "Production And Properties If SiCp-Reinforced Aluminum Alloy Composites"
2. Ramesh, J.N.Prakash, A.S.Shiva Shankare Gowda and Sonnappa Appaiah JMMCE Vol. 8 No.2 pp 93-106,2009. "Comparison Of Mechanical Properties Of Al6061/Albite And Al6061/Graphite Metal Matrix Composites"
3. G.J.Naveen and C.S.Ramesh "Microstructure and mechanical Properties of Al6061-SiCp casted composites" International journal of Engineering Science and research technology Vol.3 September 2014
4. C.S.Ramesh, A.R.Anwar khan & Mir Safiulla, Materials science and Forum, 437-438(2003)
5. S.F.Moustafa, S.A.El Badry and A.M.Sanad, "Effect of graphite with and without copper coating on consolidation, behavior and sintering of copper-graphite composites", Powder Metalurgy, V 40,(1997), No.3,201-206
6. Manoj Singla, Lakhvir Singh, Vikas Chawla, Journals of minerals and Materials characterization & Engineering Vol.8,No.10,pp 813-819
7. A.Urena, J. Rams, M. Campo and M. Sanchez, Wear 266(2009),1128-1136
8. C.S.Ramesh, A.R.Anwar khan & Mir Safiulla, Materials science and Forum, 437-438(2003)

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