ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

Microstructure and Mechanical Properties of Al6061-Sicp Casted Composites

G.J.Naveen [*], C.S.Ramesh

[*] Department of Mechanical Engineering ,Sapthagiri College of Engineering,Bengaluru,INDIA
Department of Mechanical Engineering ,PES University,Bengaluru,INDIA
gj_naveen@yahoo.co.in

Abstract

Stir casting process is used for producing discontinuous particle reinforced metal matrix composites for decades.To obtain sufficient wetting of particle by liquid metal and to get a homogenous dispersion of the ceramic particles is a challenging task.The present paper focuses on microstructure and mechanical properties of uncoated and Ni-P coated SiC reinforced Al6061composites produced by stir casting method.Electroless plating technique was used to nickel coat SiC particles.The extent of incorporation of reinforcements was varied from 2 to 10 wt% in steps of 2wt%.Major objective of the work was to obtain high quality cast MMCs with minimal porosity using metallic coated reinforcement.Results reveal that, increased content of SiC particles in matrix alloy increases various mechanical properties of both uncoated and Ni-P coated SiC reinforced composites. However, when compared with uncoated composites, Ni-P coated SiC reinforced composites exhibited improvised properties.

Keywords:Microstructure,Coating,Casting,MMC's

Introduction

Aluminium based metal matrix composites have been one of the prominent research areas in materials processing in the last few decades.Particle reinforced metal matrix composites (MMCs) are now recognized as important structural materials for application in aerospace and automotive parts. Reinforcement of light weight aluminum alloys with short fibers, platelets and particle of ceramics results in composite of high specific strength and stiffness suitable for various engineering applications[1-5].

Casting route is been favoured method as it helps in manufacture of large number of complex shaped components. Especially, the stir casting (vortex method) mostly used to produce the PRMMCs as it shows to be a very promising for manufacture of near net shape composites in a simple and cost effective method. The major problem in this technology is to obtain sufficient wetting of particle by the liquid metal and to get a homogeneous dispersion of the ceramic particles [6-8].Good wetting between solid ceramic particles and liquid matrix metal is essential to get uniform dispersion and satisfactory properties in MMC. Alloying elements are added for inducing wettability[9-11]. In the light of the above, the present investigation focuses on microstructure and mechanical properties of uncoated and Ni-P coated SiC reinforced Al6061composites produced by stir casting method.

Materials and methods

Composite Preparation

Al6061 alloy with the chemical composition given in Table1was used as the matrix material.Silicon Carbide (SiC) in powder form having particle size of range5-30µm was used as reinforcement.Silicon carbide particles were subjected to electroless nickel coating. The detailed coating procedure is as described in our earlier works [12].A batch of 4kgs of Aluminum 6061 alloy was melted using a 6KW electric furnace. The metal was degassed using commercially available chlorine based tablets (Hexachloroethane). The molten metal was agitated by use of mechanical stirrer rotating at a speed of 300 rpm to create a fine vortex. Preheated SiC powders were added slowly into the vortex while continuing the stirring process.The stirring duration was 10 minutes. The stirrer blades were made of stainless steel and coated with ceramic material to minimize the iron pickup by the molten metal.The composite melt maintained at a temperature of 710^{o}C was then poured into metallic moulds.Both Ni-P coated and uncoated silicon carbide was varied in proportions of 2 to10wt%.Coated SiC was preheated to 400^{o}C before dispersing in the molten alloy. Cast composites were machined and were subjected to microstructure and mechanical properties.Table below shows the chemical composition of Al6061 alloy.

Element	Percentage

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

Cu	0.15-0.40
Si	0.4-0.8
Mn	0.15 max.
Mg	0.8-1.2
Fe	0.7 max.
Zn	0.25 max.
Ti	0.15max.
Cr	0.04-0.35
Al	Balance

Table.1 Al6061 alloy with the chemical composition

Fig 1 Electrical resistance furnace with stirrer

Results and discussion

Microstructure

Fig 2(a) Al6061 alloy

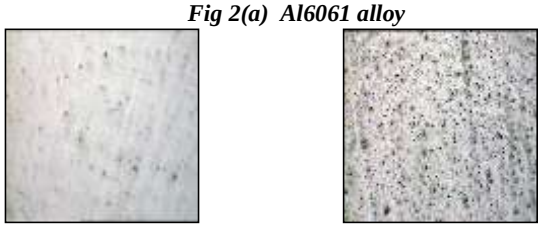

Fig 2(b)Uncoated silicon carbide reinforced Al6061 composites

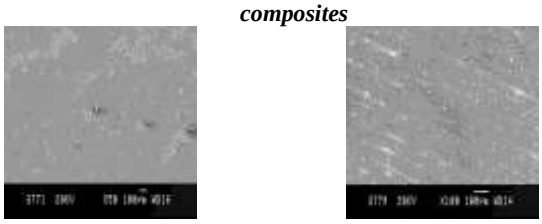

Fig 2(c) Al6061-Ni-P coated SiC composites

Figure 2(a),2(b) and 2(c)shows the SEM photographs of Al 6061 matrix alloy reinforced with uncoated Silicon Carbide powders and Ni-P coated composites. It is observed that silicon carbide particles are fairly homogeneously distributed.Agglomeration of reinforced phase is also noticed in some composites with higher weight percentage of silicon carbide particles.Further, detachment/decohesion of reinforced phase is also observed in the composites with higher magnification which is a clear evidence of poor bond between matrix alloy and reinforcement as shown in figure 2(b).It is observed that SiC particles of range 5-30 microns are found distributed in a fairly homogenous manner within the matrix alloy and also no such agglomerations/clusters are noticed in figure 2(c). Further, there exists strong interfacial bond between matrix alloy and reinforcement as a beneficial result of metallic coating.

Ultimate Tensile Strength (UTS)

Figure 3 shows the variation of ultimate tensile strength of Al 6061 matrix alloy and its cast composites. It is observed that all the developed composites have higher ultimate tensile strength when compared with the cast Al 6061 matrix alloy. A maximum improvement of 91% and a minimum improvement of 48.51% are observed for Al6061-10Wt%SiC and Al6061-2Wt%SiC respectively;where as in case of Ni-P coated SiC reinforced composites it is found to be 107% and 56.43% respectively.

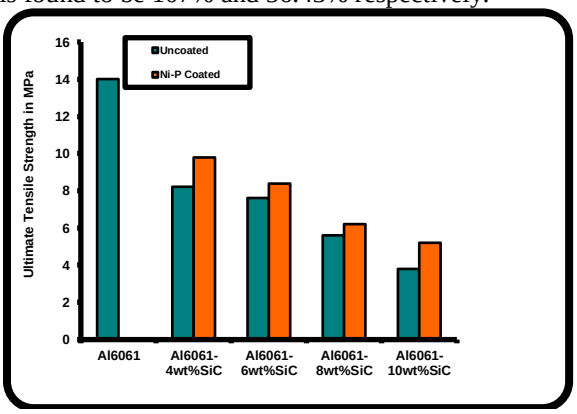

Fig 3 Ultimate Tensile strength (MPa) of Al 6061 matrix alloy and its composites.

Ductility

Figure 4 shows the ductility values in terms of percentage elongation for Al6061 and Al6061-SiC composites both for coated and uncoated conditions. It is observed that addition of SiC leads to the drastic reduction in ductility of Al6061 – SiC composites for both the coated and uncoated composites. The reduced ductility of Al6061 – SiC composites can be due to the stress concentration effects at the matrix and the SiC interface.

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

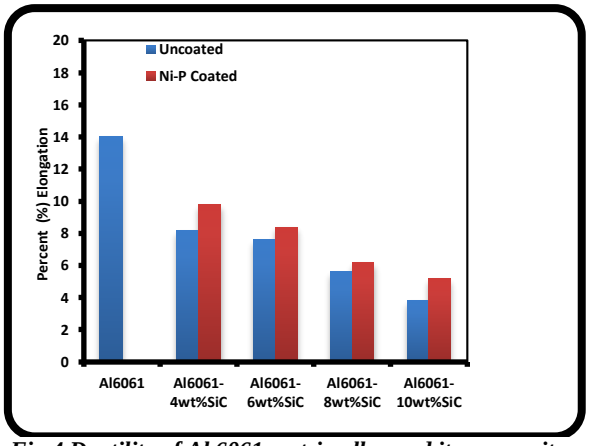

Fig 4 Ductility of Al 6061 matrix alloy and its composites

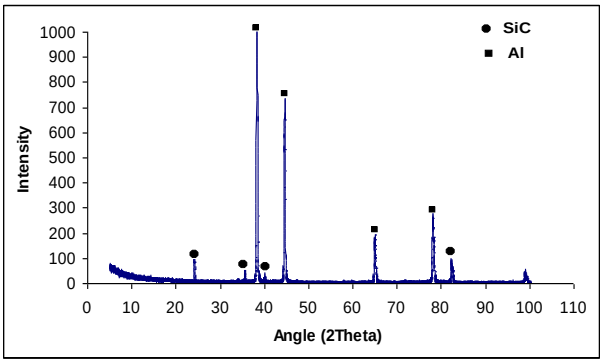

Fig 5 shows the XRD pattern of cast Al6061-10wt%SiC which indicates the presence of silicon carbide in matrix alloy.

Conclusion

1. Electroless Nickel coating was successfully carried.
2. High quality cast MMCs with minimal porosity using metallic coated reinforcement were obtained.
3. A maximum improvement of 91% and a minimum improvement of 48.51% are observed for Al6061-10Wt%SiC and Al6061-2Wt%SiC respectively. Where as in case of Ni-P coated SiC reinforced composites it is found to be 107% and 56.43% respectively.
4. Strong interfacial bond between matrix alloy and reinforcement in Ni-P coated SiC reinforced composites is a beneficial result of metallic coating
5. SEM studies and mechanical properties were evaluated.
6. Homogenous dispersion was achieved successfully.

Acknowledgements

The authors acknowledge their sincere thanks to Department of Science and Technology (DST), India, for sponsoring this research work. The authors would like to express their deep sense of gratitude to Prof.D.Jawahar, Pro Chancellor, PES University and Dr. K.N.B.Murthy, Vice Chancellor, PES University, Bangalore. My thanks and regards also go to research community in developing the article and people who have willingly helped me out with their abilities.

References

[1] P.K Rohatgi, Metal-matrix Composites, Defense Science Journal, Vol.43, No 4, October 1993, pp323-349.

[2] J.Hashim, L.Looney, M.S.J.Hashmi, Metal Matrix Composites:Production by the stir casting method, Journal of MaterialsProcessing Tech.92-93 (1999) 1-7.

[3] P.Rohatagi (2001). Cast metal matrix composites: Past, present and future. AFS Trans 2001:01-133.

[4] Subrat Ray Expanding Frontier of Metallic Materials for Structural Applications, IIM Metal News, Vol12 NO. 4 August 2009

[5] W. Zhou and Z. M. Xu, "Casting of SiC Reinforced Metal Matrix Composites," Journal of Materials Proc-essing Technology, Vol. 63, No. 1-3, 1997, pp. 358-363.

[6] R. J. Smeulders and F. H. Mischgofsky, "Direct Micros-copy of Alloy Nucleation, Solidification and Ageing (Coarsening) during Stir Casting," Journal of Crystal Growth, Vol. 76, No. 1, 1986, pp. 151-169.

[7] D. J. Lloyd,"The SolidificationMicrostructure of Par-ticulate Reinforced Aluminium/SiC Composites," Com-posite Science and Technology, Vol. 35, No. 2, 1989, pp. 159-179.

[8] P. K. Rohatgi, S. Ray, R. A. Sthena and C. S. Naren-dranath, "Interface in Cast Metal Matrix Composites," Materials Science and Engineering, Vol. 162, No. 1-2, 1993, pp. 163-174.

[9] J.Hashim, L.Looney, M.S.J.Hashmi,The wettability of SiC particles by molten aluminum alloy, Journal of Materials ProcessingTech.119 (2001) 324-328.

[10]G.S.Hanumanth, G.A Irons Particle incorporation by melt stirring for the production of metal matrix composite, Journal of Material Science 28 (1993)2459-2465.

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

[11] J.Hashim, L.Looney, M.S.J. Hashmi; Particle distribution in cast metalmatrix composites-Part II, Journal of Materials Processing Technology, 123 (2002) 258-263.

[12]C.S. Ramesh , R. Keshavamurthy, B.H.Channabasappa, S. Pramod"Friction and wear behavior of Ni–P coated Si3N4 reinforced Al6061composites" Tribology International 43 (2010) 623–634.

Author Biblography

G.J.Naveen
is presently working in the Department of Mechanical Engineering in Sapthagiri College of Engineering, Bangalore, India. He has obtained Master Degree in Manufacturing Science and Engineering from PES University (formerly P.E.S.Institute of Technology), Bangalore, INDIA and M.B.A (Operations Management) from IGNOU, New Delhi; INDIA. He has research experience and worked as teaching assistant in IIT Madras, Department of Metallurgical and Materials Engineering. He has published in journals and presented papers in conference. His area of interest are Surface Engineering especially coatings and Metal Matrix Composites. Recently was awarded Bangalore Youth International Award for outstanding contribution in the field of Science and Technology by Govt. of Karnataka, INDIA
gj_naveen@yahoo.co.in

Dr.C.S.Ramesh
is Professor and Dean, Advanced Composites Centre, PES University (formerly P.E.S.Institute of Technology), Bangalore, INDIA. He is awarded PhD from IIT Madras in the Department of Metallurgical and Materials Engineering. He holds his Bachelor Degree in Mechanical Engineering from U.V.C.E., Bangalore and Master Degree in Metal Casting from M.S.R.I.T, Bangalore with total 22 years of experience in Teaching & Research. He has published over 100 papers in international journals and conferences. Received the prestigious Prof. Satish Dhawan Young Engineers Award from Govt. of Karnataka, INDIAfor his outstanding contribution in the field of research.
csr_gce@yahoo.co.in