Journal of New Technology and Materials
JNTM
Vol. 02, N°01 (2012)22-25

OEB Univ. Publish. Co.

Investigation of Impact Strength and Hardness of Aluminum based SiC Particle Reinforced Composites

P. Sundriyal[a] and V. K. Singh[b]
[a]*M.Tech Scholar*
[b]*Associate Professor*
Department of Mechanical Engineering
College of Technology, G. B. Pant University of Agri. & Tech., Pantnagar
Uttarakhand-263145, INDIA
Email: vks2319@yahoo.co.in, Phone: +919760825833
Received: Jan 28, 2012; revised: Feb 17, 2012; accepted: Feb 20, 2012

Abstract
Metal Matrix Composites have evoked a keen interest in recent times for potential applications in aerospace and automotive industries owing to their superior strength to weight ratio and high temperature resistance. Although several technical challenges exist with casting technology yet it can be used to overcome this problem. Achieving a uniform distribution of reinforcement within the matrix is one such challenge, which affects directly on the properties and quality of composite material. In the present study a modest attempt has been made to develop Aluminum based Silicon Carbide particulate. To achieve these objectives two step-mixing method of stir casting technique has been adopted and subsequent property analysis has been made. Aluminum 6063 series and Si-C (300 mesh) has been chosen as matrix and reinforcement material respectively. Experiments have been conducted by varying weight fraction of Si-C (7%, 14% and 21%), while keeping all other parameters constant. The results indicated that the 'developed method' is quite successful to obtain uniform dispersion of reinforcement in the matrix results obtained by microstructure test. An increasing trend of hardness and impact strength with increase in weight percentage of Si-C has been observed.
Keywords: *SiC, Aluminium6063, Composites.*

1. Introduction

Aluminum metal matrix composites (AMMCs) are superior to other metal matrix composites (MMCs) due to their low cost. There has been an increased interest in the use of composite materials in the recent past due to its unique physical and mechanical properties. AMMCs are increasingly used in aircraft, automotive components, structural and electronic applications and military industries [1-3].

Though MMCs possess superior properties they have not been widely applied due to their higher manufacturing cost and also due to poor machinability [4, 5]. The components made of these materials, can be produced by near-net shape manufacturing, they usually require subsequent machining to achieve the desired geometry, assembling tolerance and surface integrity [6, 7]. Main difficulties such as fabrication, machining and cost have to be overcome while applying composites in different applications [8, 9].

Aluminum 6063 series and Si-C has been chosen as matrix and reinforcement material respectively. Experiments have been conducted by varying weight fraction of SiC (7%, 14% & 21%), while keeping all other parameters constant. The aim involved in designing metal matrix composite materials is to combine the desirable attributes of metals and ceramics. The addition of high strength, high modulus refractory particle to a ductile metal matrix produces a material whose mechanical properties are intermediate between the matrix alloy and the ceramic reinforcement. Metals have a useful combination of properties such as high strength, ductility and high temperature resistance, but sometimes have low stiffness, whereas ceramics are stiff and strong, though brittle.

2. Material and method

In the present study sand casting process has been used for fabrication of metal matrix composite. Stir casting is opted for it. Sand is used as a refractory material in sand molding systems. Mollasses is used as binder that maintains the shape of the mould while pouring molten metal. Bentonite clay is used upto 4-10% of the sand mixture in Green sand systems, which is the most common sand casting system. Water, which makes up around 2-4% of the sand mixture, activates the binder. Carbonaceous material such as charcoal (2-10% of total volume) is also added to the mixture to provide a reducing environment. It helps in preventing the metal from oxidizing while pouring. The remaining 85-95% of the total mixture contains sand.

In the present study, coal fired furnace has been used. The crucible material was Graphite. Coal has been used as the fuel. A blower has been used for supplying the required quantity of air. Al 6063 is used as a matrix material and Si-C powder is used as filler material. We had made three composites of different compositions.

7% of Si-C in Al 6063 alloy
14% of Si-C in Al 6063 alloy
21% of Si-C in Al 6063 alloy

3. Result and discussion

Many In order to investigate change in properties of casted composites with the variation of Si-C we have performed the Microstructure test, Rockwell hardness test and Izod Impact test.

Microstructure

Microstructure is defined as the structure of a prepared surface or thin foil of material as revealed by a microscope above 25× magnification. The microstructure of a material (which can be broadly classified into metallic, polymeric, ceramic and composite) can strongly influence physical properties such as strength, toughness, ductility, hardness, corrosion resistance, high/low temperature behavior, wear resistance, and so on, which in turn govern the application of these materials in industrial practice. The microstructure of the composite has been observed with the help of Inverted Metallurgical Microscope: Figures 1, 2, 3, 4, 5 show the microstructures of the Al 6063, Si-C powder, Al 6063 with 7% SiC, 14% Si-C, 21%Si-C. Figure 1 & 2 shows the micro structure of pure Al 6063 and SiC and verified with the microstructure given in research work of Shorowordi K.M [10]. It has been observed that there are some changes in the microstructures. Figures 3, 4 and 5 depicts micrograph's of samples containing 7%, 14%, 21% SiC by weight respectively developed with the help of two-step mixing method of stir casting. It clearly shows the resulting homogeneous distribution of particles in the samples.

Figure 3 shows that clusters of Si-C particles in the primary α Al seemed to be finer. This can be explained by the fact that Si-C particles have a lower thermal conductivity and heat diffusivity than those of aluminum melt and therefore, Si-C particles were unable to cool down as they melt. As a result, the temperature of the particles was somewhat higher than liquid alloy. The hotter particles may heat up the liquid in their immediate surroundings, and thus delay solidification of the surrounding liquid alloy.

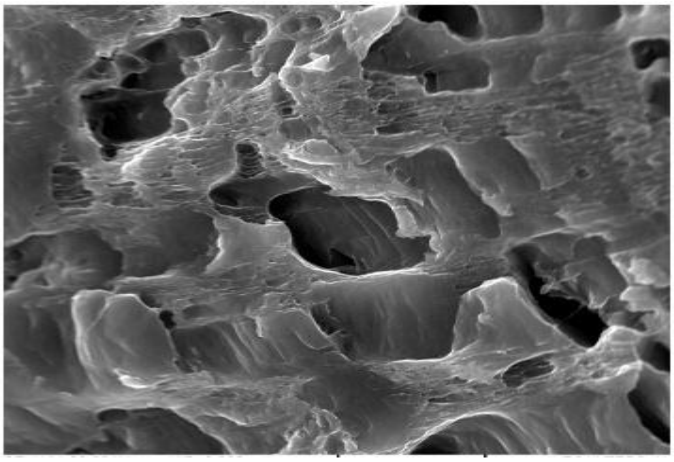

Figure 1: Al 6063 (200+ magnification)

Figure 2: Si-C, (200+ magnification)

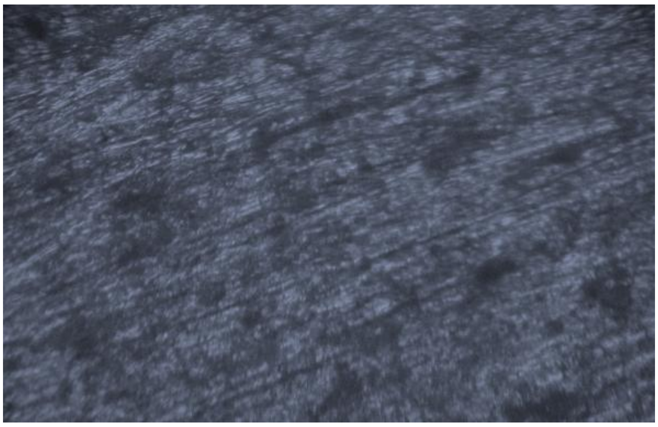

Figure 3: AL 6063 + 7% Si-C, (200+ magnification)

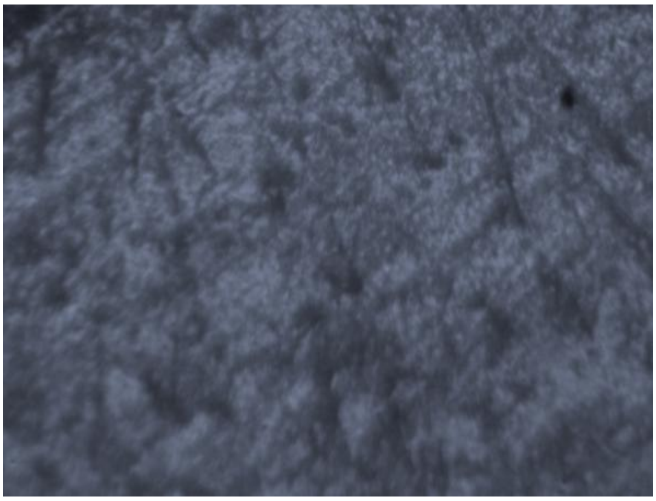

Figure 4: Al 6063+ 14% Si-C, (200+ magnification)

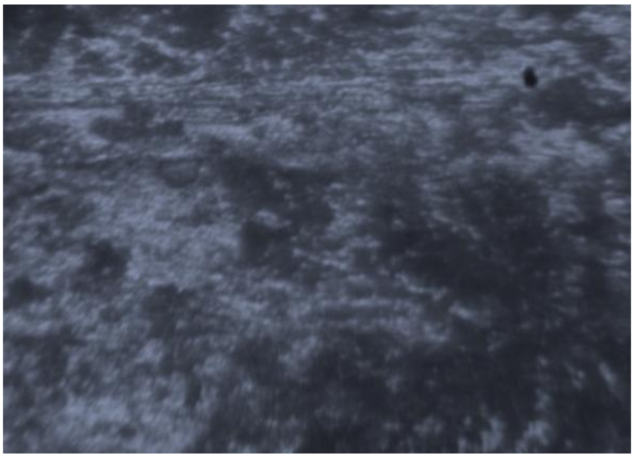

Figure 5: AL 6063+21% Si-C, (200+ magnification)

Figure 4 & 5 show the extensive growth of the dendrites. During this growth, the freely suspended Si-C particles in the melt could either be entrapped by the dendrite front or pushed ahead by the front, depending on the velocity of the growing front and geometrical compatibility between the dendrite arm spacing and particle sizes. Pushing of particles by dendrite fronts could almost certainly occur if they were not entrapped. The existence of Si-C particles can result in instability in the growth front.

Hardness Test

As known, hardness implies a resistance to indentation, permanent or plastic deformation of material. In a composite material, filler weight fraction significantly affects the hardness value of the hybrid composite material. Hardness values measured on the Rockwell C-Scale showing the effect of weight percentage of Si-C on the hardness values of composite are presented in figure 6.

The Hardness of pure Al 6063 is 36 (HRC). Figure 6 shows that pure Al 6063 exhibits the lowest hardness amongst the entire composite studied. Addition of 7wt%, 14wt% and 21 wt% of Si-C particles increases 1.97, 2.06 and 2.17 times of hardness compared to pure Al 6063 respectively. It shows that hardness increases with increasing the Si-C particle.

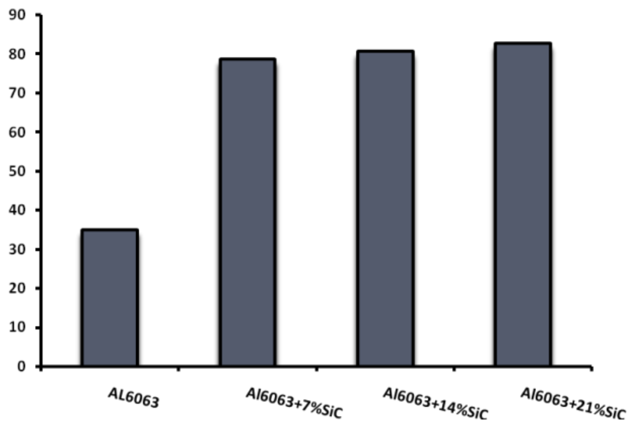

Figure 6: Variation of Hardness of composite Materials in HRC

Impact Test

For the impact testing, Izod test was performed on the notched specimens as recommended by ASTM standard for the rigid plastics. Specimen for this test had dimensions of 10x10x75mm3 as shown in figure 7. Three specimens of each type were tested in accordance with the same standard. The results obtained from the test are depicted in Figure 8.

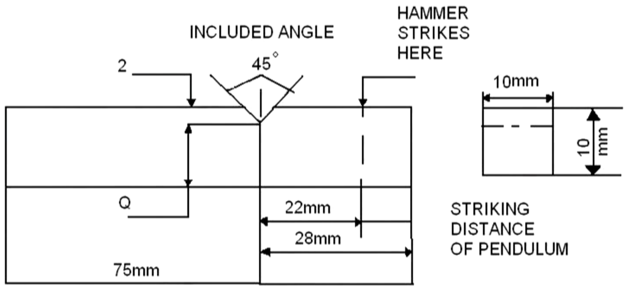

Figure 7: Specimens Geometry for Izod Test as per ASTM standard

The impact strength of pure Al 6063 is 16 Nm. Figure 8 shows that pure Al 6063 exhibits the lowest impact strength amongst the entire hybrid composite studied. Addition of 7wt%, 14wt% and 21 wt% of Si-C particles increases 31.25%, 43.75% and 75% of the impact strength as compared to pure Al 6063 respectively. It shows that impact strength increases with increasing the Si-C particle.

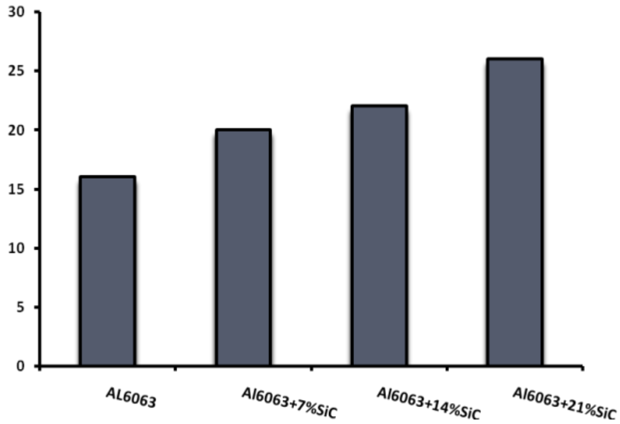

Figure 8: Variation of Impac tStrength of composite Materials in N-m

4. Conclusion

The results of experiment suggest that with increase in composition of Si-C, an increase in hardness and impact strength have been observed. With increase in composition of Si-C, the microstructures of the composites are more uniform. Homogenous dispersion of Si-C particles in the Al matrix shows an increasing trend in the samples prepared by stirring process.

Refrences

[1] K.M Shorowordi, T Laoui, A.S.M.A Haseeb, J.P Celis, L Froyen, Journal of Materials Processing Technology. (2003) 142: 738-743.

[2] O Quilgley, J Monaghan, P O'Reilly, Journal of Materials Processing Technology. (1994)43: 21-36.

[3] Sedat Ozden, Recep Ekici, Fehmi Nair, Composites: Part A. (2007) 38: 484-494.

[4] J.S Kwak, Y.S Kim. Journal of Materials Processing Technology. (2008) 20: 596-600.

[5] A Onat, H Akbulut, F Yilmaz, Journal of Alloys and Compounds. (2007)436: 375-382.

[6] M El-Gallab, M Sklad, Journal of Materials Processing Technology. (1998)83: 277 - 285.

[7] H Chandrasekaran, J.O Johansson, Annals of the CIRP. . (1997)46: 493-496.

[8] N.P Hung, F.Y.C Boey, K.A Khor., Y.S Phua, H.F Lee, Journal of Materials Processing Technology. (1996)56: 966-977.

[9] A Manna, B Bhattacharayya, Journal of Materials Processing and Technology. (2003)140: 711-716.

[10] K.M Shorowordi, T Laoui, A.S.M.A Haseeb, J.P Celis, L Froyen. Journal of Materials Processing Technology. (2003)142: 738-743