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A fabrication and Micro structural study of A384.1 Metal Matrix Composites

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Abstract: *The main objective of the present works related to the material characterization of fabricated A 384.1 by stir casting technique as increasing percentage by weight and the particle size of MgO and SiC_p increased their strengthening effect and a distinct advantage is the ability to use many combinations of resins and reinforcements especially in aerospace industry. Furthermore, the effects of reinforced particles sizes on the microstructure of the composites were observed by using SEM. The finer particles will provide more efficient barriers to dislocation flow in aluminum matrix and more homogeneously distributed. Larger particles are more susceptible to gravity settling and can result in clustering and agglomeration of reinforcement in matrix region. Morphology of reinforcement and matrix particle also influence the homogeneity of particle distribution in aluminum metal matrix composites.*

Keywords: *Particle Size, microstructure, Aluminum Metal Matrix Composites, Stir Casting Technique.*

I. Introduction

Aluminum alloy based ceramic particulate composites have been characteristic as futuristic materials are more preferred by engineers because of their great strength, low density, enhanced high refractoriness properties and damping capabilities. (Hartaj Singh et. al. 2012) have studied A 384.1-MgO based metal matrix composites that the fabricated A 384.1 as AMMCs with percentage of increased MgO the relative particle size and mechanical behavior under tensile strength can be accomplished [1]. (Harinder pal Singh et. al. 2012) have invested the tensile strength of al 384.1 based SiC_p reinforced metal matrix composite and showing the better interfacial relation in between the matrix and the reinforced material by keeping the smaller particle size of SiC_p. Therefore, the contribution of the particle size is more significant than the percentage of SiC_p [2]. (Nripjit et.al 2009) have studied Al_2O_3 in A 384.1 metal matrix composites were found to increase hardness and ultimate tensile strength and composites showed higher peak hardness and lower peak ageing time as compared to the unreinforced Aluminum alloy. In addition, ageing is found to increase the strength, micro and macro-hardness of the fabricated composites. The reinforced composite samples with different particle sizes of Al_2O_3 in µm were also fabricated to further investigate the interfacial characteristics. It is observed that the samples with small particle size exhibited clustering. The composites are fabricated by a simple and cost-effective stir casting technique and the results show that composites have higher modulus compared with the unreinforced alloy. The composites exhibit higher peak hardness and accelerated ageing compared with the unreinforced alloy. A 384.1-Al_2O_3-5% composite shows higher ultimate tensile and compressive strength compared with unreinforced Al Alloy at peak-aged condition. $(A384.1)_{1-x}[(SiC)p]_x$ composite containing varying percentage by weight of SiC with particle size were fabricated. It is observed from X-ray diffraction that with the increase in percentage of the reinforced particle, the homogeneous and uniform distribution of metal in matrix of the composite material increases and thus the interfacial structure bonding is comparatively strong in this system as evidenced by the improved mechanical properties of these materials [3-6]. (Suresh R and M. Prasanna Kumar et. al. 2013) have experimented that the wear rate and coefficient of friction decreased linearly with increasing weight percentage of Al_2O_3. The wear rate increase as the sliding speed increases. The best results of minimum wear have been obtained at 8% weight fraction of Al_2O_3. The SEM of Aluminum 6061 composites produced by stir casting method shows that the fair uniform distribution of graphite and Al_2O_3 particles in the metal matrix. The incorporation of Al2O3 and graphite particles as reinforcements improved the tribological behavior and caused a reduction in the wear rate of Aluminum 6061 composites during the dry sliding process [7]. (Serajul Haque et. al. 2013) have studied a modest attempt has been made to find out the process parameters at which best mechanical properties of Al6061, 4% Cu and reinforced 5% SiC_p ceramic MMC can be obtained and more or less comparable to the composition of duralumin, which is widely used in aerospace applications. SiC_p is hard and having linear thermal expansion at high temperature. With reinforcement of SiC_p in Al-Cu alloy, it can be postulated that hardness of MMCs retains at high temperature applications [8]. (Suryanarayanan et. al.) 2013 have studied that factors such as reactivity at the interface, volume fraction of the reinforcing material, type of the reinforcing material and distribution of the reinforcing material are reviewed using the existing literature.

Using the information available, the paper advocates the use of Al-SiC MMC in the fuselage skins of high performance aircrafts [9]. (Sawla et. al. 2004) have investigated that MgO and SiC particles are harder than other reinforcements and will provide a more effective barrier to subsurface shear by the motion of the adjacent steel counter face and this result is likely due to differences in particles shapes. In addition, reinforcement liberated as wear debris acts as a third body abrasive to both surfaces [10]. (Shao-Yun et. al. 2002) have experimented the tensile behavior of hard particle reinforced composite depends primarily on the type of interfacial bonding between the Al-matrix and the reinforcement. This is because of the strong interfacial bond which plays a critical role in transferring loads from the matrix to the hard particles. In case of heat treated alloy, the effective stress applied on the composite surface during wear process is less due to higher strength and ductility of the Al matrix. This resulted in less cracking tendency of the composite surface as compared to the cast alloy [11]. (Soon-chal et. al. 2006) The heat treatment did not radically change the morphology but hardening of the matrix by precipitation hardening took place, which led to higher hardness and strength. The conclusions made over the years by numerous investigators in the field of particle reinforced Al-MMCs. The mechanical properties were reviewed with respect to strength [12].

II. Sample Fabrication Methodology

The Stir casting mechanism has been developed by using vertical muffle furnace with graphite crucible the billet of A 384.1 alloy were preheated and the material is incorporated into the molten metal by stirring. This involves stirring the melt with ceramic particles of reinforced SiC and MgO 5%, 10%, 15% by weight at different levels, and then allowing the mixture to solidify. This can usually be prepared by means of fairly conventional processing equipment and can be carried out on a continuous and semi continuous. The technology is relatively simple and low cost in order to fabricate the Al-MMC samples at least three pieces of each samples at different percentage by weight as per the standard specimen specifications [13].

III. Results & Discussion

3.1 Morphology studies

It has been observed that after going through the literature survey as much work is done on SiC_p based Al-MMCs as compared with MgO based Al-MMCs. The microstructure of A 384.1 alloys and reinforcements particles SiC_p, and MgO are fairly and uniformly distributed agglomeration of particles based composites and interface bonding between the matrix and reinforced particles are quite sharp indicating reasonably good bonding a Al-MMCs by varying weight percentages of morphology study has been obtained. As the density increases, the MMC becomes stiffer since the molecules do not have as much space to move around one another. Also as the molecular weight increases, the entanglement of the molecules resists movement. Along with reduction in porosity, a better distribution of particles was achieved in all alumina composites. The size, shape and texture of the initial well-structured silicon

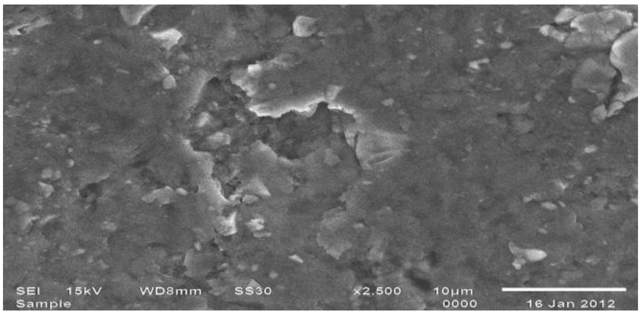

Figure 1. (a) At 5 % (wt.) of MgO-AMMCs.

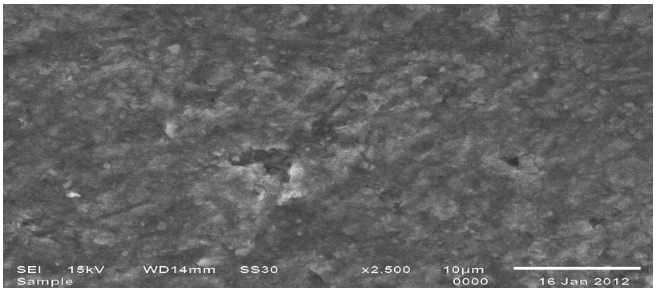

Figure 1. (b) At 10 % (wt.) of MgO-AMMCs.

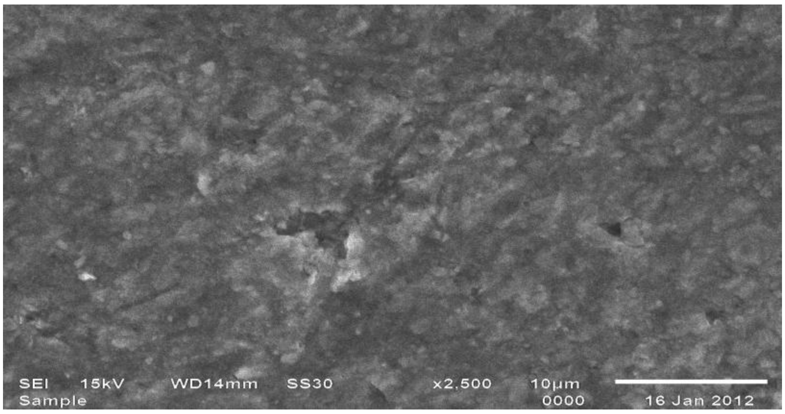

Figure 1. (c) At 10 % (wt.) of MgO-AMMCs.

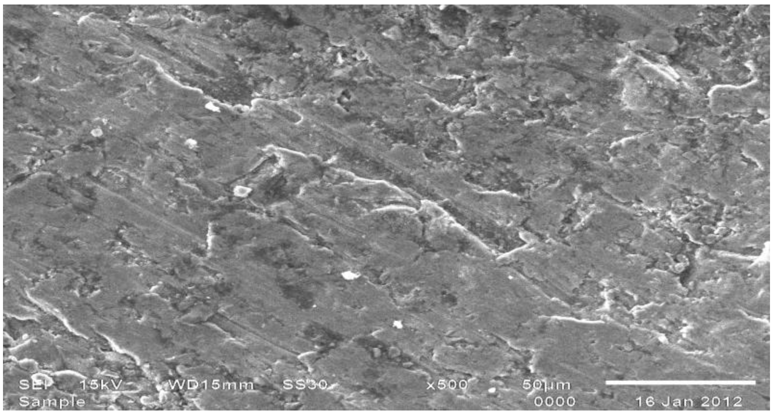

Figure 1. (d) At 10 (wt.) % of SiC_p-AMMCs.

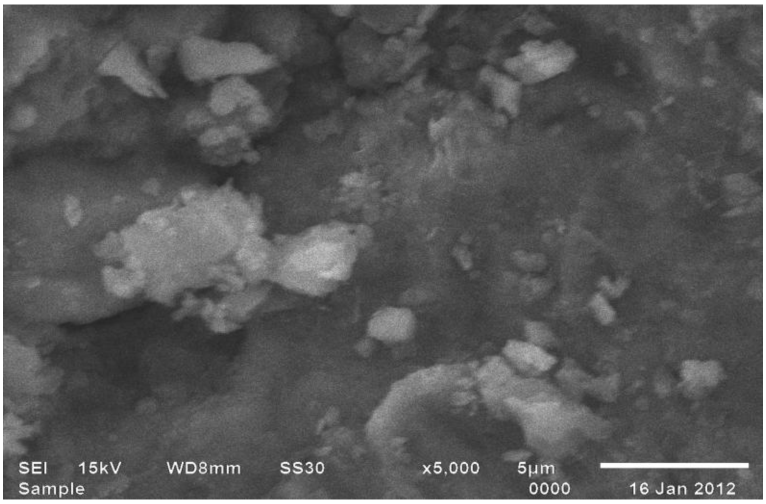

Figure 1. (e) At 15 % (wt.) of SiC_p-AMMCs.

carbide and under Scanning electron microscopy (Model: SEM–JSM 6600) Relatively greater degree of magnesium oxide were studied using Secondary electron imaging mode of Scanning electron microscopy. SEM image of initial silicon carbide particles are mostly angular at 5% weightage of reinforcement in shape. Here the angular structure of initial silicon carbide has been destroyed and the flake shaped particles are observed with the increase at 15% of weightage reinforcement of MgO and SiC_p furthermore, the final shape of the particles is mostly sub-angular and the surface morphology is rough as shown in Figure 2 (a), (b), (c), (d) and (e) and as shown in Figure 3 (a) and (b). illustrated EDS. The X-Ray Diffraction and SEM study shows that the addition of MgO particles in different amount of sizes and varying percentage of particle sizes in the casting is also found to be observed the strengthening of composites particularly, at 10% of MgO can be moderated in terms of dispersion strengthening due the reinforcements of particles.

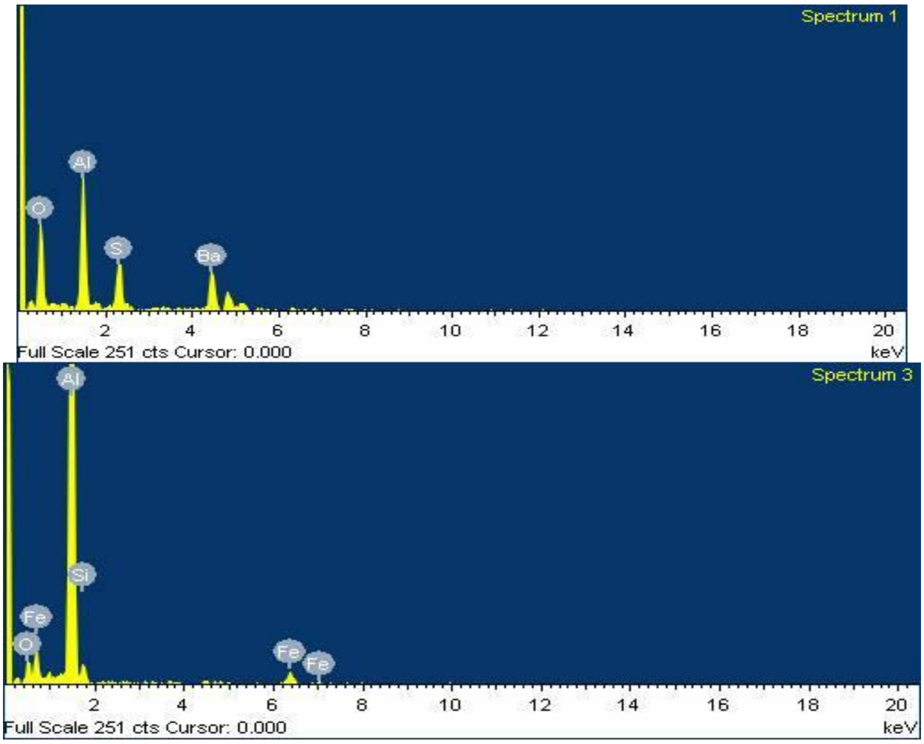

Figure 2 (a), (b). Illustrate EDS Spectra of different phases observed in SEM micrographs of MgO and SiC_p.

3.2 X-Ray Diffraction Measurements

The sample preparation of XRD is done as per the standard practice and measuring the diffraction pattern therefore allows us to deduce the distribution of atoms in a material. The X-ray diffraction measurements were carried out with the help of a Goniometer = PW3050/60, 0.1 Angstrom, Minimum step size 2θ:0.001, Minimum step size Omega:0.001, Sample stage=PW307 using Cu Kαradiation (Kα= 1.54056 A^0) at an accelerating voltage of 40 mA and a current of 45 KV. In this test the sample was in stationary condition, only the arms of the X- ray tube was rotating in the opposite direction from 10 to 120 and with a scan type is continuous. The analysis was find out crystallite size, peak height, crystallinity of the materials of silicon carbide and magnesium oxide was characterized. In x-ray crystallography, integrated intensities of the diffraction peaks are used to reconstruct the electron density map within the unit cell in the crystal. The most efficient way to do this is by using an area detector which can collect diffraction data in a large solid angle from 0°to 120°. The use of high intensity x-ray sources and the amplitude of diffracted waves vary form C-6200 to 110 in case of AMMCs, 10% (wt.) of MgO from SiC_p different atoms can interfere with each other and the resultant intensity distribution is strongly modulated by this interaction. If the atoms are arranged will consist of sharp interference maxima with the same symmetry as in the distribution of atoms.

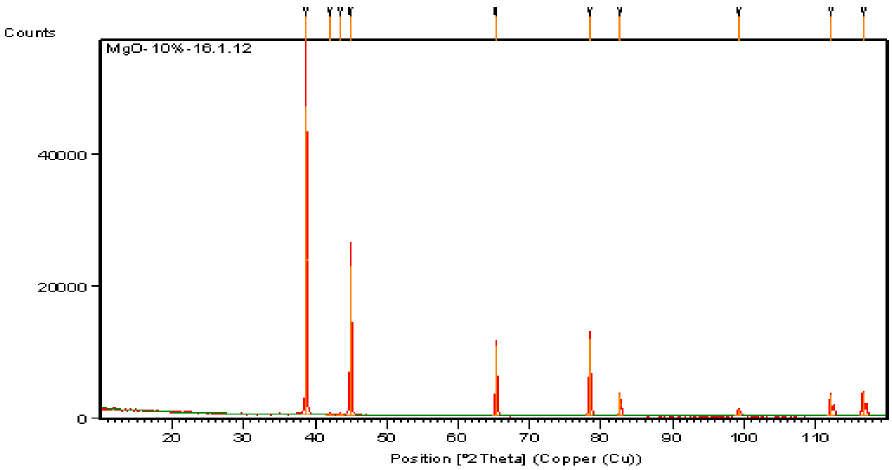

Figure 3. (a) AMMCs with 10 % (wt.) of MgO.

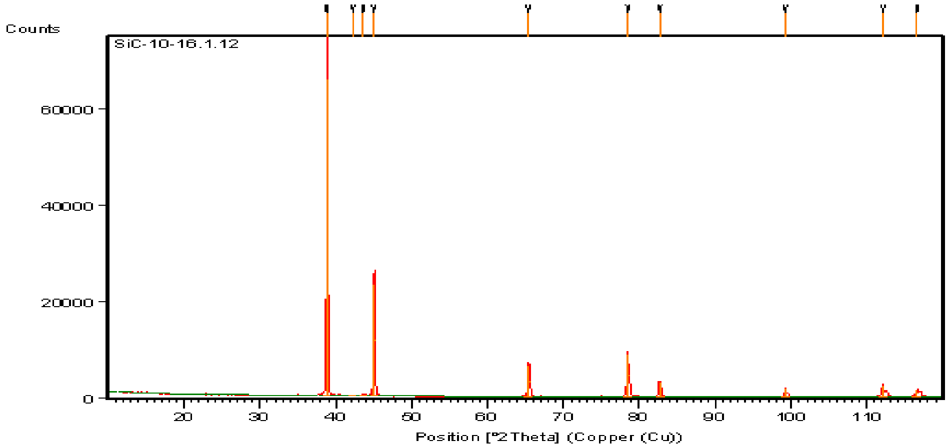

Figure 3. (b) AMMCs with 10 % (wt.) of SiC_p.

IV. Conclusions

1. The present results shows that AMMCs casting development by stir casting method is cost effective method and to get uniform distribution of the reinforced particles and homogeneous properties can be achieved by using SEM and XRD.
2. The development of casted A 384.1 that with increase in composition of MgO and SiC_p of percentage and particle size of MgO and SiC_p at different has be investigated shows that smaller particle size will more fined structures as compared to large particle sizes..
3. It has been observed with the help of EDS the percentage point of views, the contribution of percentage of MgO is larger as compared to the percentage of SiC_p.

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References

[1]. Hartaj Singh, Sarabjeet, Nrip jit, 2012, "Studies on A 384.1-MgO based metal matrix composites and optimization of tensile strength using taguchi technique", JERS, Vol.3 (1), 61-64.
[2]. Harinder Pal Singh, Nripjit, Sarabjeet, A.K.Tayagi, 2012, "Investigation of tensile strength of al 384.1 based SiCp reinforced metal matrix composite (MMC)", JERS, Vol.3(1), 149-151.
[3]. Nripjit, Anand K. Tyagi, Nirmal Singh, 2009, "Al-Cu-Si - (Al2O3)p composites usingA 384.1 Al Alloys", Asian Journal of Chemistry, Vol. 21(10)
[4]. Nrip jit,Anand K. Tyagi, Nirmal Singh, 2006, "Evolution of metal casting (A review study)", Proceeding of International Conference on AME, 295-298.
[5]. Nripjit, Nirmal Singh, Anand K. Tyagi, 2007, "Development, processing and recent research of Al alloy composites", Proceedings of International Conference on Advanced Materials and Applications, Vol. 31,1-15.
[6]. Nrip Jit, Anand K Tyagi, Nirmal Singh, Dayal Chand, 2011, "Properties of (A384.1)1x [(SiC)p]x Composites by Keeping Particle Size at 0.220 µm", Proceedings of the World Congress on Engineering Vol 3, London, U.K.
[7]. Suresh R and M. Prasanna Kumar, 2013, "Investigation of tribological behavior and its relation with processing and microstructures of Al 6061 metal matrix composites", IJRET, Vol. 1 (2), 91-104
[8]. Serajul Haque, P.K.Bharti, Akhtar hussain Ansari, 2013 "Study of the Effect of Process Parameters on Mechanical Properties and Microstructure of Al-Cu and SiC_p Reinforced Metal Matrix Composite", IJET, Vol.4 (6), 427-431.
[9]. Suryanarayanan K., R. Praveen, S. Raghuraman, 2013 "Silicon Carbide Reinforced Aluminium Metal Matrix Composites for Aerospace Applications: A Literature Review", IJIRSET, Vol. 2 (11), 6336-6344.
[10]. Sawla S, Das S, 2004 "Combined effect of reinforcement and heat treatment on the two body abrasive wear of Al-alloy and aluminum particle composites", Wear 257, 555-561.
[11]. Shao-Yun Fu, Guanshui Xu, Yiu-Wing Mai., 2002 " Study on the elastic modulus of hybrid particle/short-fiber/polymer composite", Composites: part B33, 291-299.
[12]. Soon-Chul Kwon, Tadahrru adachi, Wakaka Araki, Akihiko Yamaji, 2006, "Thermo- viscoelasticproperties of silica particulate-reinforced epoxy composites: Considered in terms of particle packing model ", Acta Materialia Vol. 54, 3369-3374.
[13]. Surappa MK and Rohatgi RK, 1981 "Preparation and Properties of cast aluminum ceramics particle composites" journal of Material Science, Vol. 16, 983-993.