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Review on Effect of Hybrid Reinforcement on Mechanical Behavior of Aluminium Matrix Composite

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Abstract—**In current industrial scenario composite material has lot of Scope due to its Mechanical properties like hardness, toughness, Compressive strength& tensile strength. Conventional monolithic materials have limitations with respect to Composite material. Development of hybrid metal matrix composites has become an important area of research interest in Material Science. Aluminum alloys are widely used in aerospace and automobile industries due to their low density and good mechanical properties, better corrosion resistance and wear, low thermal coefficient of expansion as compared to conventional metals and alloys. The aim of the present investigation is provide the detailed review on effect of hybrid reinforcement on mechanical behavior of aluminum matrix composite.**

The paper deals with the fabrication of aluminum based hybrid metal matrix composite and then characterized their mechanical properties such as hardness, toughness and tensile strength. In the present study a modest attempt has been made to develop aluminum based silicon carbide particulate MMCs with an objective to develop a conventional low cast method of producing MMCs and to obtain homogeneous dispersion of ceramic material. To achieve this objective stir casting technique has been adopted.

The overview indicates that the developed method is quite successful and there is an increase in the value of tensile strength, hardness and toughness with increase in weight percentage of reinforcement.

Keywords— Aluminum alloys, Matrix, Hybrid Reinforcement, Hybrid composite.

I. INTRODUCTION

Composite material is defined as it has two or more distinct phases one is Matrix phase and reinforcement phase and having bulk properties having significantly different from their matrix constituents[1].Conventional monolithic materials have limitations with respect to achievable combinations of strength, stiffness, and density. Metal matrix composites (MMCs) have emerged as a class of materials capable for advanced structural, automotive, electronic, thermal management, and wear applications. MMCs compare to conventional materials provide the specific mechanical properties necessary for elevated and ambient temperature applications [2]. Al based composites have been successfully utilized in and the huge prospects it has for so many other new applications.

From the development of high performance components for automobile, aerospace, defense, marine and other notable industrial applications to the Development of facilities for sports and recreation , the areas of application of Al based composites is expected to still continue to grow. Aluminum metal matrix composite (AMC) now have a proven track record as successful "high-tech" materials in a range of applications. AMC utilization provides significant benefits including performance benefits (component lifetime, improved productivity), economic benefits and environmental benefits. Engineering viability of AMCs in a number of applications have been well-documented. Particle reinforced aluminum matrix composites of all the AMCs, particle reinforced AMCs constitute largest quantity of composites produced and utilized on volume and weight basis. AMCs are produced by PM /stir cast/melt Infiltration/spraying/in situ processing techniques at industrial level [3].

Particulates of SiC, Al_2O_3, TiC, TiB_2, and B4C have been used as reinforcements. AMCs have been successfully used as components in automotive, aerospace, opto-mechanical assemblies and thermal management. Presently AMC brake discs are extensively used in European Railways and are in use in certain models of passenger cars in U.S.A. Potential automotive applications of AMCs include valves, crankshafts, gear parts and suspension arms.

A. Stir Casting Method of Fabrication of MMC.

Stir Casting is a liquid state method of composite materials fabrication, in which a dispersed phase (ceramic particles, short fibers) is mixed with a molten matrix metal by means of mechanical stirring as shown in figure. The liquid composite material is then cast by conventional casting methods and may also be processed by conventional Metal forming technologies. Distribution of dispersed phase throughout the matrix is not perfectly homogeneous. There are local clouds (clusters) of the dispersed particles (fibers). There may be gravity segregation of the dispersed phase due to a difference in the densities of the dispersed and matrix phase. The technology is relatively simple and low cost [11].

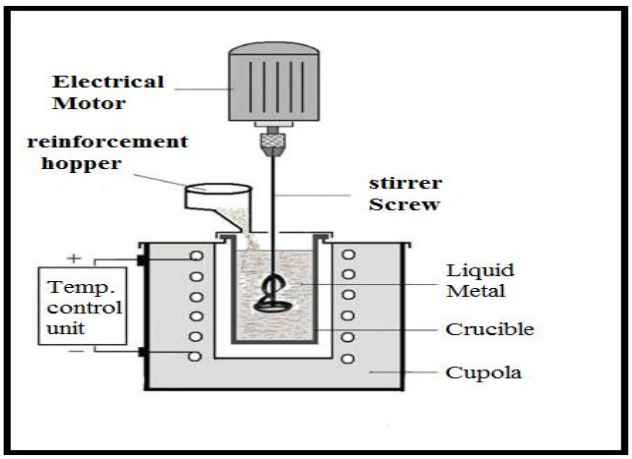

Fig.1. -*Stir casting set up*

II. REVIEW

To enhance mechanical & wear characteristics of the hybrid composite and to change in wear resistance of Composite material with respect to increasing percentage of reinforcement. Therefore this paper concentrates on the review of Aluminum alloy matrix composites reinforced with Hybrid can be successfully synthesized by the stir casting method. For Synthesizing of hybrid composite by stir casting process, stirrer design and position, stirring speed and time, melting and pouring temperature, particle-preheating temperature, particle incorporation rate, mould type and size, and reinforcement particle size and amount are the important process parameters. With the addition of hybrid reinforcement instead of single reinforcement more than one reinforcement is added and then hardness, toughness, strength, corrosive and wear resistance of the composite will be increasing further increased. The present will help to investigate the various aspects of hybrid composite material like mechanical behavior while increasing percentage of reinforcement.

Sharanabasappa R Patil et.al.,[1] have investigated the results of an experimental investigation of the mechanical properties of fly ash and Alumina reinforced aluminum alloy (LM25) composites samples, processed by stir casting route. The main mechanical properties were studied the tensile strength, ductility impact strength & hardness. It was found that the tensile strength & hardness of the aluminum alloy (LM25) composites increases with the increase in %wt of Al_2O_3 upto certain limit. In addition of more amount of reinforcement the and the charpy test shows decrease in impact load absorption with increase in %weight reinforcement. The main objective of study is fabricate the hybrid metal matrix composite successfully by using Fly ash and Alumina as particulate. Results of hybrid composite are also compared with simple composite and with parent metal it shows significant properties.

Sandeep Kumar Ravesh et.al., [2] have developed aluminum based metal matrix composite and then characterized their mechanical properties of it based silicon carbide particulate MMCs with an objective to develop a conventional low cast method of producing MMCs and to obtain homogeneous dispersion of ceramic material. Aluminum 6061 and SiC, Fly Ash has been chosen as matrix and reinforcement material respectively. He has been concluded that the developed method is quite successful and there is an increase in the value of tensile strength, hardness and toughness with increase in weight percentage of Sic. the purpose of this paper manufacture the hybrid composite material by using SiC and Fly ash by using stir casting techniques. It is used to develop metal matrix composite materials is to combine is to desirable properties of metals and ceramics. This experimentation gives Superior properties of these materials such as refractoriness, high hardness; high tensile strength, wear resistance etc. make them suitable for use as reinforcement in MMCs.

Mahendra Boopathi et.al., [3] studied silicon carbide and fly ash [SiC (5%) + fly ash (10%) and fly ash (10%) + SiC (10%)] with aluminum, it was fairly observed that the density of the composites was decreased and the hardness was increased. Correspondingly, the increase in tensile strength was also observed but elongation of the hybrid metal matrix composites in comparison with unreinforced aluminum was decreased .Aluminum in the presence of SiC (10%)-fly ash (10%) was the hardest instead of aluminium-SiC and aluminum-fly ash composites. Density of the composites decreased by increasing the content of the reinforcement. Hence, it was found that, instead of Al-SiC and Al-fly ash composites, Al-SiC-fly ash composites show better performance. So these composites can be used in applications where to a great extent weight reductions are desirable. Tensile strength, yield strength and hardness were determined for the test materials. Increase in area fraction of reinforcement in matrix result in improved tensile strength, yield strength and hardness. this study also show that With the addition of SiC and fly ash with higher percentage the rate of elongation of the hybrid MMCs is decreased significantly. Optical micrographs revealed that both the SiC and fly ash particles are well distributed in aluminum matrix. From the above results we can comment that instead of Al-SiC or Al-fly ash composites, the Al-SiC-fly ash composites could be considered as an exceptional material in sectors where lightweight and enhanced mechanical properties are essential.

K.K.Alaneme et.al.,[4] studied low cost – high performance Al matrix hybrid composites with the use of bamboo leaf ash (an agro waste ash) and silicon carbide as complementing reinforcements was investigated. The results show that the hardness, ultimate tensile strength, and percent elongation of the hybrid composites decrease with increase in BLA content. The fracture toughness of the hybrid composites were however superior to that of the single reinforced Al 10wt% SiC composite. Only the 2 wt% BLA containing hybrid composite had specific strength value comparable to that of the single reinforced composite. In 5wt% NaCl solution, it was observed that the 2 and 3 wt % BLA containing hybrid composites had higher corrosion resistance in comparison to the single reinforced Al - 10 wt% SiC composite but the reverse trend was observed in 0.3 M H_2SO_4 solution where the

single reinforced had superior corrosion resistance.this paper results shows that The hardness, ultimate tensile strength,and percent elongation of the hybridomposites decreased with increase in BLA content. The fracture toughness of the hybridcomposites was observed to be superior tothat of the single reinforced Al - 10 wt%SiC composite. The specific strength of the 2 wt % BLA containing hybrid composite was comparable to that of the single reinforced - 10 wt% SiC composite while the 3 and4 wt % BLA containing hybrid composites had lower specific strength values.

S. cemokumus et.al., [5] Studied Aluminum-silicon based hybrid composites reinforced with silicon carbide and graphite particles were prepared by liquid phase particle mixing (melt stirring) and squeeze casting. The thermal expansion and thermal conductivity behaviors of hybrid composites with various graphite contents (5.0; 7.5; 10 wt. %) and different silicon carbide particle sizes (45 μm and 53 μm) were investigated. Results indicated that increasing the graphite content improved the dimensional stability, and there was no obvious variation between the thermal expansion behaviors of the 45 μm and the 53μm silicon carbide reinforced composites. In that paper effort are made to manufacture successful hybrid composite material. The distributions of SiC and graphite particles in the MMCs were homogeneous and macroscopically free of pores indicating the production of the hybrid composites were succeeded. Introducing graphite particles into Al-Si based hybrid MMCs reinforced with SiC particles (~20 vol. %) resulted in decreased thermal expansion of the composites, since SiC has lower thermal expansion coefficient than that of aluminum matrix. Introducing a high amount of graphite to the Al-Si matrix alloy was found to be beneficial to the dimensional stability of SiC reinforced Al-Si based hybrid MMCs. Results revealed that graphite particles absorb the thermal expansion because of their layered structure. The CTE of the Al-Si based hybrid MMCs was found to be lower when the graphite content was increased for both (45 μm and 53 μm) SiC reinforcements of these composites. TC was found to decrease as the content of reinforcement and the temperature increases, since the reinforcements have lower TC values than that of matrix alloy and because, increased temperature diminish the thermal diffusivity.

M.Sreenivasa Reddy et.al .,[6] Metal Matrix Composites (MMCs) constitute an important class of design and weight-efficient structural materials that are encouraging every sphere of engineering applications and mainly in aerospace applications. The MMC is obtained for the different compositions of E-glass and Fly ash particulates. The results are plotted and it is concluded that the MMC obtained has got better tensile strength compared to Aluminum alloy (7075) alone. Further, tensile strength slightly increased with 1 hour aging heat treatment. It is observed that the densities of composites are higher than that of their base matrix, further the density increases with increased percentage of filler content in the composites. It is observed that the tensile strength of the composites is higher than thatof their base matrix also it can be observed that the increase in the filler content contributes in increasing the tensile strength of the composite. In microstructure studies it is observed that, the distributions of reinforcements in the respective matrix are fairly uniform.

Prabhakar Kammer et.al. [7] Studied on Conventional monolithic materials have limitations in achieving good combination of strength, stiffness, toughness and density. Metal matrix composites (MMCs) possess significantly improved properties including high specific strength; specific modulus, damping capacity and good wear resistance compared to unreinforced alloys. Among the MMC's aluminum composites are predominant in use due to their low weight and high strength. The key features of MMC's are specific strength and stiffness, excellent wear resistance, high electrical and thermal conductivity. The present investigation aims at the development of Aluminum based E-Glass and Fly ash particulate reinforced hybrid metal matrix composites. The test specimens are prepared. as per ASTM standard size by turning and facing operations to conduct tensile and compression test.

III. CONCLUSION

The following conclusions can be drawn from the present review: Aluminum hybrid metal matrix composite is successfully fabricated by stir casting techniques. the mechanical properties like tensile strength ,yield strength ,Hardness are increasing as compare to simple composite while the percentage of reinforcement increasing .while the other end elongation gets reduced in composite as percentage reinforcement gets increased. With the addition of hybrid reinforcement instead of single reinforcement the hardness, toughness, strength, corrosive and wear resistance of the composite will be increasing further increased. Optical micrographs revealed that hybrid particals particles are well distributed in aluminum matrix. So, hybrid composite will give better result than simple composite material.

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