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A Review on Mechanical Properties and Tribological Characteristics of Stir Cast Aluminium Metal Matrix Composites

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Abstract

This paper presents a review on the behaviour of mechanical and tribological Characteristics of Aluminium Metal Matrix Composites developed by different processes. Hybrid composites have proved their great performance with excellent versatility. The advantages of Metal Matrix Composites (MMCs) of Aluminium are high strength to weight ratio, high erosion and wear resistance with comparatively low cost. They are employed in several applications like steel making, structural, marine, aerospace, defense, automobile division due to its thermal stability and incredible specific strength. These Metal Matrix Composites (MMCs) are unconventional engineering materials which are reinforced with materials having better-quality mechanical and tribological behavior. Reinforcement like particulate alumina, silicon carbide, TiO_2, Boron carbide, graphite and fly ash are mainly used. This paper presents a review on the mechanical properties and tribological behavior besides their reinforcement in various applications. Different reinforcements have different effect on Aluminium composites. For example, Boron carbide addition improves the elastic modulus, electrical conductivity, tensile strength and thermal electrical conductivity due to its lubricating property. Aluminium oxide addition results in good tribological behavior. Fly ash adding produces an increase in yield strength, tensile strength and overall mechanical properties. Similarly other reinforcements have their particular effect on the Al composites.

Keywords: Aluminium metal matrix composite, reinforcement, silicon carbide, alumina, graphite, tribological behavior, Mechanical properties.

1. INTRODUCTION

Metal Matrix composite (MMC) is a mixture of Metal (Matrix) and hard particle/clay (Reinforcement) which gives desirable properties. It is used in the manufacture of Space Craft, Automobiles and other equipment. The expanded requirement of lightweight materials with high particulate quality in the aviation and car enterprises has prompted to the improvement and utilization of Al amalgam based composites (basically Al combination/SiC composites).[1] The MMCs are appealing materials for use in basic applications since they join ideal mechanical properties, great wear resistance, and low warm extension [2]. The half and half SiC foam SiC particles/Al double interpenetrating composites utilized as the brake materials of fast prepare were created by press throwing procedure [3] The MMCs are metals reinforced with other metal, dismissed or natural mixes. Reinforcement is done to enhance the properties of the parent metal, like, conductivity, quality, etc. [4]. The Aluminium MMC is generally utilized as a part of air ship, aviation, autos and different fields [5]. The most ordinarily utilized strengthening does include Silicon Carbide and Aluminium Oxide. Silicon Carbide (SiC) supports sizes the rigidity, hardness, thickness and wear resistance [6]. Aluminium is the most giving metal in the Soil's outside layer, and the third most immeasurable component, after oxygen and silicon. It makes up around 8% by weight of the Soil's strong surface [7]. The cost of producing composite materials utilizing a throwing technique is around 33% larger than that of aggressive strategies besides high volume creation [8].

2. LITERATURE REVIEW

2.1 Aluminium metal matrix composites

Aakash Kumar et al [9] show a survey on the mechanical properties and tribological conduct alongside their microstructural development that is acquired after their support at different fixations. AnilKumar et al [10] have picked Al 6061 combination as the matrix material and fly ash remains with changing weight rate (10%, 15%, and 20%) with particle estimate [of 4-25, 45-50, 75-100 μm] as the strengthening to deliver the composite by mix throwing. By examining the example, the hardness, rigidity, compressive quality increments with increment in weight division of fly ash debris. Bienia et al [11] investigated the set consumption conduct and corrosion energy of Al compound. In this strategy, they have utilized AK12 as the MMCS and fly ash as the strengthening to create the composite by gravity throwing and press throwing. Fly ash particles prompt to an improved setting erosion of the AK12/9% fly ash remains composite in analysis with unreinforced matrix.

2.2 Al6061, SiC, Al_2O_3, and B_4C Matrix Composites

Ravi et al [12] tells that AMCs are the prepared material in the mechanical properties. They are approximately used as a part of aviation, vehicle, marine businesses, and so on because of their great mechanical material properties. The AMCs is reinforcements when it is strengthened with hard fired particles like SiC, Al_2O_3, and B_4C. Ramadan et al [13] reports the aftereffects of rough wear tests on examples of persistent Silicon Carbide (SiC) and high quality Carbon (H.S.C) filaments strengthened Al(1100) and Al(6061) matrix materials, with 50-60% fiber volume portion, and made by matrix fiber covering and hot-solidification manufacture handle. Sahin et al [14] discussed about the wear conduct of SiCp-strengthened Aluminium composite delivered by the liquid metal blending technique, explored by method for a stick on-circle sort wear fix. Rough wear tests were completed on 5 vol. % SiCp and its matrix composite against SiC and Al_2O_3 emery papers on a steel counter face at a settled speed. Selvi et al [15] researched the mechanical properties of Al MMCs hypothetically and tentatively and furthermore inferred that the fly ash particles enhance the wear resistance of the Al MMC and the nearness of SiO_2 in fly ash increment wear resistance of Al MMC and that progressions of wear rates are seen in the sliding wear test.

3. STIR CASTING

A current advancement in blend throwing procedure is a twofold mix throwing or two-stage blending method. Now the preheated strengthening particles are included and blended. Again the slurry is warmed to a completely fluid state and blended altogether. In twofold blend throwing the subsequent microstructure has been observed to be more uniform as contrasted and ordinary mixing (Saravanan et al [16]).Strategic additional three stage blend throwing strategy for manufacture of nano subdivision encouraged composite. Now the first place support as well as Al particles stand mixed utilizing ball plants to break the connecting bunching of nano particles. When necessary mixing the composite slurry is sonicated using an ultrasonic investigation or transducer so as to enhance the distribution of encouraged particles. The important preferred position of blend throwing procedure is its materialness to large scale manufacturing. Compared with other creation techniques, mix giving procedure costs a role as low-slung as $1/4^{rd}$ to $1/11^{th}$ for huge measure manufacturing of MMCs. In light of the above reasons, mix throwing is the most generally utilized business technique for creating Aluminium based composites. Girot et al [17]).

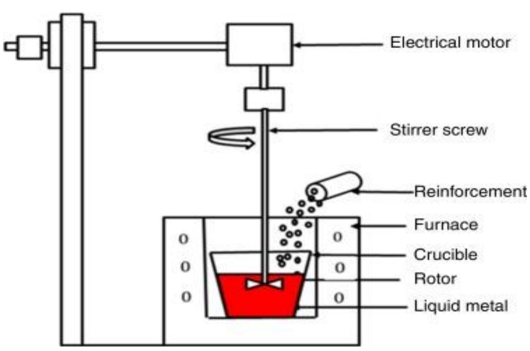

Figure 1: Stir casting Investigational set up (Maruyama [17])

4. MECHANICAL PROPERTIES

The mechanical properties of a composite rely on many variables such sort of support, amount of strengthening, shape, estimate and so forth. The correct comprehension of the mechanical conduct is accordingly fundamental as they are utilized in various zones.

Kakaiselvan et al [18] created Al 6061and B_4C composite and researched its mechanical properties. They watched that the hardness and the rigidity fig 2 of the composite are straightly expanding with expanding weight rate of the B_4C particulate. Baradeswaran et al [19] concentrated the mechanical conduct of B_4C fortified AL-7075 matrix composite. The creator has uncovered that a definitive rigidity the compressive quality fig 3 and the hardness of the composite expanded straightly with increment in volume rate of B_4C.

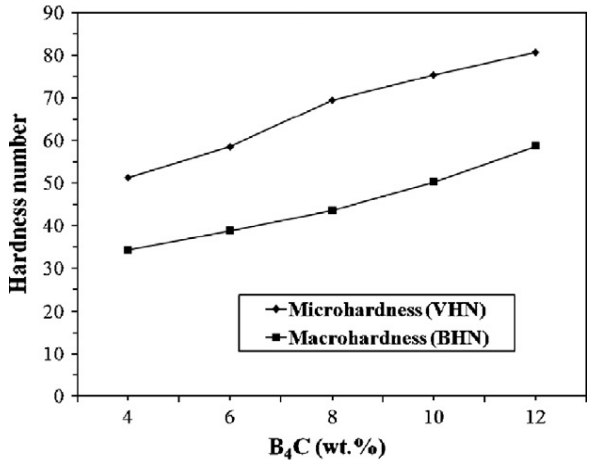

Fig: 2 Variety of hardness with B_4C content (Kakaiselvan et al [18])

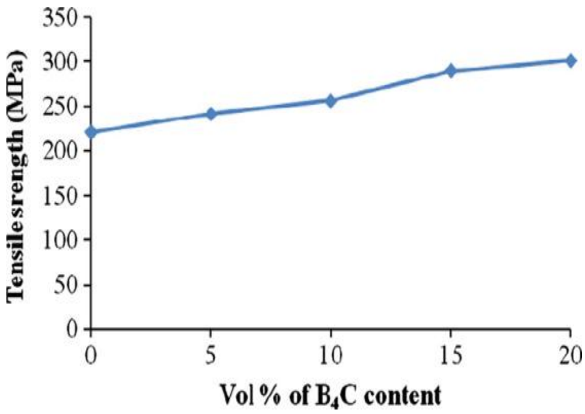

Fig: 3 Variation of TS with B_4C content (Baradeswaran et al [19])

Mazahery et al [20] observed that the continuation break initially expanded and afterward diminished with increment in strengthening.as shown in figure.4.

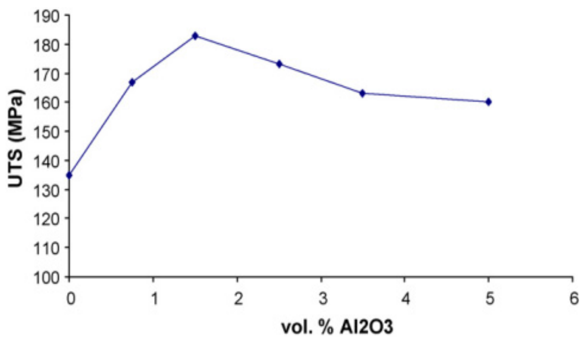

Fig: 4 Variation of UTS with Al_2O_3 content (Mazahery et al [20])

Ashwath et al [21] revealed that the hardness values because of alumina and SiC increments as their fixation increments as appeared in figure 5. It is likewise watched that hardness esteem is improved more because of SiC particles when contrasted with alumina particles. Because of graphite expansion over 10 wt. %, the sinter couldn't be shaped in light of the fact that the quantity of graphite particles surpassed the quantity of metal matrix particles.

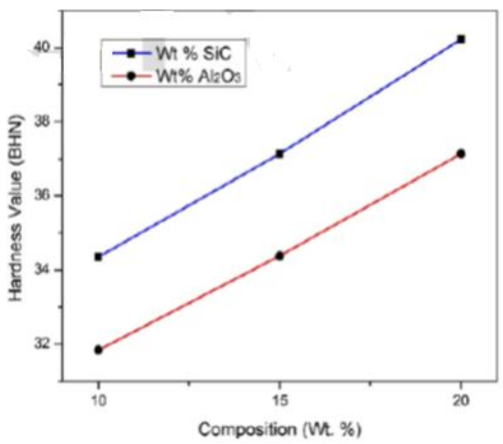

Figure 5: Showing the variation of hardness value with composition of Al_2O_3 and SiC (Ashwath et al [21])

5. TRIBILOGICAL PROPERTIES

Tee et al [22]. The creator has uncovered that wear misfortunes of the both composite diminished with increment in volume division of Tib_2. Figure 6 demonstrates that as the sliding separation builds wear misfortune additionally increments yet at significantly less rate contrasted with unadulterated compound. Likewise the wear resistance of the Al-Tib_2 composite was higher than Al-4.5% Cu-Tib_2 composite. The creators watched that wear rate expanded with expanding connected load, sliding separation and grating size for SiC emery paper while it diminished with sliding separation for Al_2O_3 paper. Sanjeev Das et al [23] Aluminium mixture based composite reinforced with alumina and zircon sand an expansion in wear resistance for both the composites with decline in particle size of the support. The creator additionally uncovered that wear resistance of zircon sand fortified composite was superior to Al_2O_3 strengthened composite as shown in figure 7.

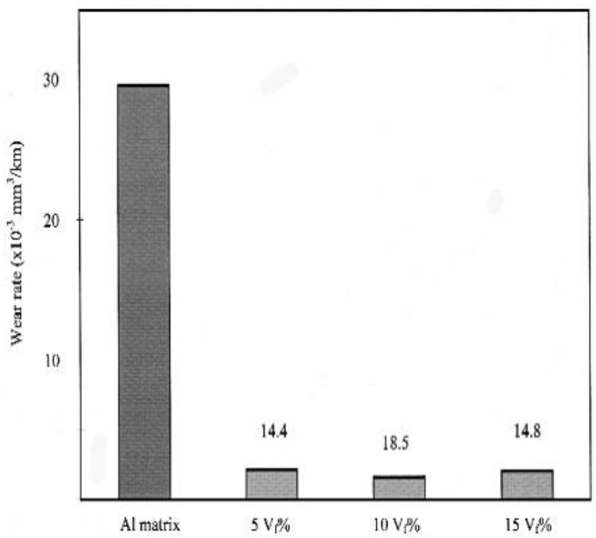

Fig: 6 Variation of wear rate Tee et al [22]

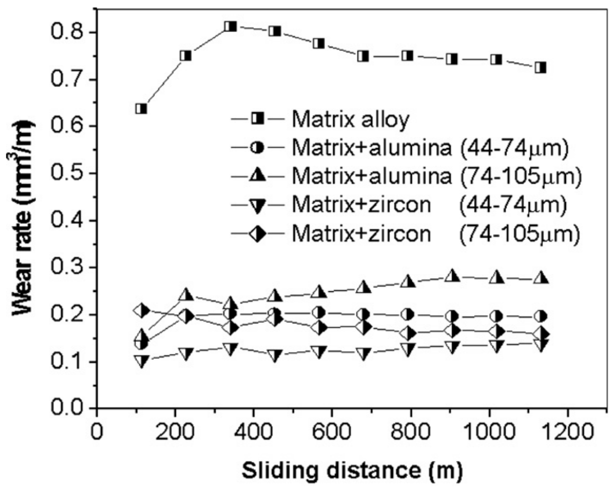

Figure 7: Variation of wear rate (Sanjeev Das et al [23]

6. CONCLUSION

The above review for the stir cast Aluminium metal matrix composites prompts to the corresponding conclusions:

1. Stir casting method can be effectively used to manufacture metal matrix composite (MMC) with favorite properties.
2. Aluminium or its compound with the hard creative particulates like B_4C, TiB_2, and SiC and so on increments the mechanical and tribological performance of metal matrix composites to a great extent because of the strong interfacial relationship between the reinforcement and the Al matrix.

3. Reinforcing of Aluminium mixtures with alumina nanoparticles shapes the elasticity and hardness together with elasticity.
4. Establishment Al matrix with TiB_2 or SiC enhances the tensile and hardness conduct up to certain wt. % of SiC or TiB_2 development and from that point a lot of decrement is seen in rigidity and hardness in view of group arrangement or accumulation of these hard clay particles in Aluminium matrix and which prompts to porosity.
5. 5.Though dissimilar collecting procedures like mix casting, press throwing and powder metallurgy are employed for the manufacture of different Al metal matrix composite however at the same time blend throwing strategy is effectively utilized be reason for its more extensive availability and furthermore it is generally reasonable than different strategies.
6. The expansion of graphite as support has likewise established a noteworthy increment in rigidity yet reduce in locales exposed that with reduction in coefficient of grating, there is addition in the wear rate which upgrades the machining properties. Excessive graphite expansion may prompt to remove the liquid soften of Al matrix.
7. The constituency of natural strengthening with Aluminium or its combination is not all around investigated and extraordinarily controlled work has been done in this field. Nonetheless, a few outcomes demonstrated a significant increment in mechanical and additionally tribological behavior. Along these lines, more investigation is required in this field for further development of AMMCs.
8. Facilitate improvement is required in improving the wettability and controlling the interfacial structure of the composite. Similarly, the carbon and expensive stone metal compo locations has not been investigated much which can be profitable in enhancing the mechanical and tribological behavior of AMMCs.
9. Hybrid ceramic reinforcement has extended the mechanical properties much more than the tribological properties.
10. The mould can be preheated to 220°C to 350°C to reduce the porosity in the composites which results in increase in density of the composites. Agglomeration of reinforcement may take place if the adding of reinforcement is above 20% in the matrix which reduces the mechanical and tribological properties of the composites.

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