A Review on Machining of Hybrid Aluminium Metal Matrix Composites

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Abstract-*Now a days, there is a growing interest worldwide in manufacturing hybrid metal matrix composites which possesses combined properties of its reinforcements and exhibit improved physical, mechanical and tribological properties Aluminium-based Metal Matrix Composites have received increasing attention in recent decades as engineering materials. Use of single reinforcement in Al matrix may sometimes lead to deterioration in its physical properties. However, to overcome the drawback of single reinforced composites, the concept of use of two different types of reinforcements is being explored in Al matrix. Of the two reinforcements normally one of the reinforcement will be a hard phase and the other being a soft lubricating phase. Hard reinforcements such as SiC, TiO_2, Al_2O_3, TiB_2 etc. will enhance the hardness and abrasive wear resistance of Al while it has a negative effect on the machinability and conductivity of Al. To offset these effects, reinforcements like graphite which is a solid lubricant and possessing good conductivity can be dispersed in Al along with hard reinforcements.*

Key Words: Hybrid Metal Matrix Composite, Machinability

1. INTRODUCTION

The sustainable growth of industry greatly depends on the use of alternative product in various fields. Hybridization is a process of adding two or more reinforcements in the base matrix material in order to yield a better stiffness. Composite materials are heterogeneous mixtures of two or more homogeneous phases which have been bonded together. Aluminium based hybrid metal matrix composites have wide ranging applications in automobile, aerospace and military industries because of their attractive properties such as high strength to weight ratio, high wear resistance, high temperature stability etc. The Aluminium matrix Hybrid composites are expected to have excellent wear resistance and Friction property due to the combined effect of the strength of hard reinforcements like Silicon Carbide rendered to the matrix and lubrication property of reinforcement like Graphite. Hybrid composites are formed by reinforcing two or more materials. [5]

Despite the recent developments in the near net shape manufacture, composite parts often require post-mold machining to meet dimensional tolerances, surface quality and other functional requirements . The presence of hard particles like Silicon carbide particles in Aluminium Matrix Composites poses considerable difficulties when machining these materials and also leads to rapid tool wear. Machining processes such as turning, drilling and milling of Aluminium Matrix Composites therefore requires the use of carbide, diamond or hard-nitride-coated tools. The difficulties associated with the machining of Aluminium Matrix Composites must be minimized if these materials are to be used more extensively. The introduction of a ceramic material into a metal matrix produces a composite material that results in an attractive combination of physical and mechanical properties which cannot be obtained with monolithic alloys. [7]

The reinforcement material like Silicon carbide is composed of tetrahedral of carbon and silicon atoms with strong bonds in the crystal lattice. It has high thermal conductivity coupled with low thermal expansion and high strength giving exceptional thermal shock resistant properties. It is used in abrasives, refractories, ceramics, and numerous high-performance applications. Another reinforcement material like Graphite, a solid lubricant which enhances the wear and anti-frictional properties. The acoustic and thermal properties of graphite are highly anisotropic. Graphite's high thermal stability and electrical and thermal conductivity facilitate its widespread use as electrodes and refractories in high temperature material processing applications. Graphite and graphite powder are valued in industrial application for their self-lubricating and dry lubricating properties. It possess excellent mechanical properties, such as good corrosion resistance, good deformation behaviour, high specific modulus, tensile strength, hardness, good wear resistance and low coefficient of thermal expansion. Aluminium alloys, are typically characterized by following properties [11]

- fluidity
- Castability
- Good corrosion resistance
- High strength-weight ratio
- Improved wear resistance
- High specific strength

Due to their high strength-to-density ratio aluminium alloys are often used in transport applications, including marine, automotive and aviation. These same properties lead to its use in rock climbing equipment, bicycle components, inline skating-frames, and camera lenses, brake components, valves and couplings. [33]

2. REINFORCING MATERIALS IN ALUMINIUM METAL MATRIX COMPOSITES

The overall properties of the hybrid metal matrix composite depend on individual properties of the reinforcement material selected and type of the matrix alloy. The processes root of manufacturing, shape, size, and chemical affinity with matrix material of reinforcement materials influence their microstructure, physical properties, tribological properties and other desirable properties of the composite. Different ceramic materials that are generally used to reinforce aluminium alloys in MMCs are Silicon carbide, titanium carbide, zinc carbide, boron carbide, silicon oxide, silicon nitride, etc. It was found from literature survey that B4C possesses better hardness property than other reinforcement materials. [35]

3. PROCESSING TECHNIQUES FOR HYBRID ALUMINIUM METAL MATRIX COMPOSITES

Aluminium hybrid composites are a modern generation of metal matrix composites which have the potentials of satisfying the recent demands of advanced engineering applications. These demands are met due to improved mechanical properties. The performance of metal matrix composites materials is mostly dependent on selecting the right combination of reinforcing materials since some of the processing parameters are associated with the reinforcing materials. One of the way for fabrication of the Aluminium metal matrix composites is by using liquid state processes such as Stir casting, Compo casting, Squeeze casting, Spray casting, In situ processing and Ultrasonic assisted casting.[36]

Stir casting process is the simplest and most commercially used technique used for processing of metal matrix composites. The process includes addition of particulate reinforcements into liquid aluminium and melt it further allowing the mixture to solidify, Creating good wetting ability between the particulate reinforcement and the liquid aluminium alloy melt is important. Properties of prepared composites developed by this method can be altered by varying different process parameters such as pouring temperature, preheat temperature, stirring speed, processing temperature, melt temperature etc.

The Compo casting is another liquid state process in which reinforcement particles were added to a solidifying melt while being vigorously agitated. The primary solid particles already formed in the semisolid slurry can mechanically entrap the reinforcing particles, prevent their gravity segregation and reduce their agglomeration. These will result in better distribution of the reinforcement particles.

In Squeeze casting ,a movable mould part called ram used for applying pressure on the molten metal and force it to penetrate into a preformed dispersed phase, placed in the lower fixed mould part. In spray casting fibres are wounded onto a foil-coated drum and spraying molten metal onto them to form a mono tape. The source of molten metal may be powder or wire feedstock which is melted in a flame or plasma.

The Ultrasonic probe assisted casting method has been proved to be very effective method in dispersing nanoparticles in the metal matrix. It includes ultrasonic probe with a transducer and power source heating furnace, reinforcement addition mechanism, and inert gas atmosphere. Ultrasonic vibrations are used to degas and purify the metal melt and improve the wettability of particle reinforcement.

Another way of fabrication of Aluminium metal matrix composites is Solid state processes such as powder metallurgy, high energy ball milling, friction stir process diffusion bonding, Physical vapour deposition techniques.in powder metallurgy powdered materials are blended, pressed into desired shape and heated to bond between surfaces. Properties of prepared composites depends upon characteristics of reinforcing materials and matrix. For uniform microstructure to occur sufficient diffusion is must.

In high energy ball milling process, mechanical energy is transferred in form of high impact from high energy and high frequency balls to the material being developed. This Method is best suited for development of high density nanostructured metal matrix composite powders with enhanced mechanical properties.

Diffusion bonding works on the principle of solid-state diffusion, where the atoms of two solid, metallic surfaces intersperse themselves over time. Here continuous fibres or preforms are sandwiched between foils of the matrix material and then subjected to high pressure on elevated temperature, to establish a bond between the matrix and reinforcement materials.

Physical vapour deposition involves continuously passing of fibres through a high partial pressure region of the metal to be used as matrix. On condensation a thick metal coating is produced on the fibres. This method uses heating process to produce a vapour of matrix metal, which is then deposited on the fibre.

4. LITERATURE REVIEW

Muniaraj A , they studied thrust force and surface roughness in drilling of al/sic/gr hybrid metal matrix composites and concluded that coated carbide tool performs better than multifaceted carbide drill in terms of improved surface finish. And Feed rate is found to have significant influence on the thrust force and surface finish. The surface roughness value increases with the increase in feed rate and decreases with the increase in spindle speed. [1]

Anthony Xavior, studied on Machinability of Hybrid Metal Matrix Composites and focuses on the influence of reinforcement particle's types, shape, size and volume fractions on the machinability issues like the cutting force, tool wear, chip formation and surface roughness. Further, the role of various cutting parameters like cutting speed, feed, depth of cut and tool material, tool geometry and cutting conditions during turning of hybrid metal matrix composites are critically reviewed. Concluded that the surface roughness mainly depends on the feed rate followed by the cutting speed. Influence of the approach angle is less on the surface roughness of the metal matrix composite. Presence of lubricating property reinforcements like graphite enhances the surface finish due to the reduction of friction and its presence improves the machinability. [2]

Niranjan K N , they studied on Al 6061 hybrid composite material containing Silicon carbide and Graphite particulates and concluded that Hardness of the prepared hybrid composites is higher than the base Aluminium 6061 alloy. Addition of Silicon carbide increases hardness considerably. Whereas the addition of Graphite particulates decreases the hardness, but is higher than the Aluminium 6061 alloy. However, decrease in hardness of Aluminium 6061-hybrid composite possibly due to poor wetting characteristics of Graphite by Aluminium 6061. Tensile strength of prepared Aluminium 6061 hybrid composites is higher when compared to base Al 6061 composite. It can be seen that as the Silicon carbide and graphite content increases, the compressive strength of the hybrid composite material also increases. [3]

Lokesh T, studied the Mechanical and Morphological properties of Aluminium 6061 with Graphite and Silicon carbide Hybrid Metal Matrix Composites concluded that Addition of Silicon carbide and Graphite particulates into the Aluminium 6061matrix (hybrid composites) improved the UTS compared to the base Al 6061 material, Aluminium-Graphite and Aluminium-Silicon carbide composites. The heat treatment has a profound effect on increase in the strength and hardness of the composites.Al6061-Gr-Silicon carbide hybrid composites were promising engineering materials in the mechanical aspects of composites. [4]

Gurpreet Singh, they worked on optimization of the machining parameters for surface roughness during turning of Aluminium/Silicon carbide/Graphite hybrid metal matrix composite. The Taguchi method, a powerful tool for experiment design, was used to optimize cutting parameters for effective turning of hybrid Metal matrix composites. The results shows that the minimum surface roughness obtained at lower speed, lower feed rate and lower depth of cut. [5]

Vamsi Krishna, they studied mechanical properties of the Aluminium 6061/Silicon carbide/Graphite hybrid composites and concluded that tensile strength, of the composites greatly influenced by the weight fractions. The mechanical behaviour of Silicon carbide/Graphite reinforced hybrid composites showed improved results when compared with single reinforcement. Density increases with Silicon carbide and decreases with Silicon carbide/Graphite hybrid particulates, so these Silicon carbide/Graphite hybrid composites can be regarded as a useful light weight Engineering Material. [6]

P Suresh, they studied on optimization of machining parameters in turning of Aluminium-Silicon-Graphite hybrid metal matrix composites concluded that Metal matrix composites reinforced with graphite particles provide better machinability and tribological properties. [7]

Sasimurugan, T, they studied on Analysis of the Machining Characteristics on Surface Roughness of a Hybrid Aluminium Metal Matrix Composite (Al6061-SiC-Al2O3) and the result indicates that the increase of cutting speed, depth of cut and feed rate. Cutting speed reduces the surface roughness. In order to obtain reduced average surface roughness it is recommended to use medium cutting speed, minimum feed rate and lower depth of cut. [8]

Devaraju Aruri, they studied the influence of tool rotational speed on wear and mechanical properties of aluminium 6061-Silicon carbide based surface hybrid composites and concluded that Low wear rate was exhibited in the Al–Silicon carbide/Graphite surface hybrid composite due to mechanically mixed layer generated between the composite pin and steel disk surfaces which contained fractured Silicon carbide and Graphite. The presence of Silicon carbide particles serves as load bearing elements and Graphite particles acted as solid lubricant. [9]

Yahya Altunpak, they studied on Drilling of a hybrid Aluminium/Silicon carbide/Graphite metal matrix composites with diamond-like carbon coated cutting tools and concluded that inclusion of graphite as an additional reinforcement in Aluminium/Silicon carbide reinforced composite reduces the cutting force. The cutting speed and its interactions with feed rate are minimum. Feed rate is the main factor influencing the cutting force in both composites. The surface roughness value was proportional with the increase in feed rate while inversely proportional with cutting speed in both composites. [10]

Harish Garg, they studied on improvement in machinability of Aluminium Hybrid Metal Matrix Composites and concluded that there is essential need to select proper machining process for effective machining of hybrid Aluminium Metal Matrix Composites .The non-traditional machining technique like Electrical Discharge Machining can be used to obtain the improved results. [11]

S Suresha, they studied the Effect of addition of graphite particulates on the wear behaviour in aluminium–silicon carbide–graphite composites concluded that Al– Silicon Carbide/Graphite hybrid composites are better substitutes to Aluminium–Graphite composites owing to improved hardness and wear resistance as a result of addition of Silicon carbide particulates to Aluminium–Graphite composites. Analysis of overlaid contour plots envisages that, increase in percentage reinforcement reduces wear up to around 7.5% of percentage reinforcement and beyond this the wear has a tendency to increase for Aluminium–Silicon–Graphite hybrid composites. Thus, the optimal percentage reinforcement can be around 7.5% for any value of sliding distance, sliding speed. [12]

Basavarajappa, they studied on Tool Wear in Turning of Graphitic Hybrid Metal Matrix Composites at different cutting conditions with carbide, coated carbide, and polycrystalline diamond (PCD) tools. The results reveal that the incorporation of graphite in Aluminium composite reduces tool wear at all cutting conditions. This is due to graphite, which reduces the coefficient of friction between tool and work piece and between tool and chip interface. PCD tool performs better than carbide and coated carbide tools. [13]

Jinfeng Leng, they studied effect of flaky graphite particles with volume fraction 3–7 percent on machinability and mechanical properties of on Aluminium Silicon carbide Graphite hybrid composites. Results showed that the machinability was improved realty with the increasing volume fraction of graphite particles. [14]

Manna A, B. Bhattacharayya, they have done work to investigate the influence of machining parameters, cutting speed, feed and depth of cut on the cutting force and surface finish during turning of silicon carbide particulate aluminium metal matrix composite and concluded that the flank wear rate is high at low cutting speed due to the generation of high cutting forces and formation of Built Up Edge during machining of Aluminium composites. High speed, low feed and low depth of cut are recommended for better surface finish. [15]

M. El-Gallab, they studied on Tool performance while Machining of Aluminium Silicon carbide particulate metal matrix composites Despite the superior mechanical and thermal properties of particulate metal-matrix composites, their poor machinability has been the main deterrent to their substitution for metal parts. The hard abrasive reinforcement phase causes rapid tool wear during machining and, consequently, high machining costs. A series of dry high-speed turning tests were performed to select the optimum tool material, tool geometry and cutting parameters for the turning of 20%SiC-Aluminium metal-matrix composites. The results indicate that polycrystalline diamond tools (PCD) provide satisfactory tool life compared to alumina and coated-carbide tools. [16]

Madeva Nagaral, they studied on dry sliding wear behaviour of Aluminium 6061 reinforced silicon carbide and graphite concluded that volumetric wear loss is depended on load considered and sliding rate. Scanning electron Microscope (SEM) images clearly shows uniform distribution of support particles in Aluminium 6061 base matrix. [17]

Deepak D, studied on optimizing machining parameters for turning Al 6061 robust design principles so as to minimise surface roughness. Concluded that federate, cutting speed and depth of cut are important parameters for determining surface roughness. [18]

Nagaral M, worked on comparing wear behaviour of Al 6061 reinforced with 6%SiC and Al 6061 reinforced with 6% Gr composites concluded that Wear resistance of Al 6061 alloy increased after addition of SiC and Gr particles. The volumetric wear loss is affected by load and sliding speed. It was observed that significant increase in volumetric wear loss as applied load and sliding speed increases. Aluminium reinforced with 6% Graphite shows less wear than Aluminium with 6% Silicon carbide. [19]

Manna A and Bhattacharyya B, they have experimentally investigated the influence of cutting conditions on surface finish during turning of Aluminium Silicon Carbide-MMC. Taguchi method, a powerful tool for experiment design was used to optimize the cutting parameters for effective turning of Aluminium Silicon Metal matrix composites using a fixed rhombic tooling system. [20]

Prakash C H and Pruthviraj R D, they have studied that the major drawbacks of Zinc-Aluminium based composites as reduced conductivity and poor machinability. To overcome this, graphite was added as reinforcement to the Zinc-Aluminium composites. Graphite being a solid lubricant can improve the machinability of the composites. Furthermore, graphite possess excellent thermal and electrical conductivity thereby, can improve the conducting capability of Zinc-Aluminium composites. [21]

G Rajaram, S.Kumaran, they studied the behaviour of composite at higher temperature by adding graphite to the aluminium silicon carbide composite. The Aluminium Silicon and graphite composite can perform well up to 300˚C, but the alloy can withstand till 250˚C. During direct metal to metal contact, the graphite particles from composite pin surface forms a thin tribo film between surfaces. Tearing and formation of oxide layer and graphite film is a continuous process which results in decrement of wear rate for composite, when the operating temperatures are increased.[22]

L Krishnamurthy B.K Sridhara D, worked on experimental investigation on the comparative machinability of aluminium silicon carbide composites and aluminum-graphite-silicon carbide hybrid composites during turning using carbide tool inserts. The experiments carried out were based on central composite design of experiments approach. The influence of machining parameters like cutting speed, feed and depth of cut on the resultant force has been analysed statistically. It is established that hybrid composites have better machinability when compared to aluminum-silicon carbide composites. [23]

Manchang Gui, they worked on aluminium hybrid metal marix composites and production of aluminum matrix composite coatings containing Silicon carbide, as well as aluminium hybrid composite coatings containing Silicon carbide and graphite particles was explored by plasma spraying of premixed powders onto a solid aluminium alloy substrate. In both Aluminium with Silicon carbide and Aluminium with Silicon carbide and Graphite composite coatings, Silicon carbide particles have a quite uniform distribution, while the distribution of graphite particles is inhomogeneous was observed. [24]

F Akhlaghi , they studied on hybrid Aluminium reinforced with Graphite and Silicon carbide composites and the presence of hard Silicon carbide particles in these hybrid composites increases the hardness and strength and compensates for the weakening effects of graphite. Here in situ powder metallurgy is applied for preparation of Aluminium/Silicon carbide/Graphite hybrid composites. The Aluminium/Graphite/ Silicon carbide compacts were prepared by cold pressing of different powder mixtures and after sintering, the effects of Silicon carbide content on the density, microstructure, hardness and wear properties were investigated. [25]

Adrian Iosub , they studied on machining of hybrid metal matrix composites by using EDM method concluded that The hybrid Silicon carbide /Aluminium composite material can easily be machined by EDM and a good surface quality can be obtained by controlling the machining parameters. The influence of the most relevant parameters of Electrical Discharge Machining over material removal rate, electrode wear and machined surface quality of a hybrid metal matrix composite were studied. The material used in this study is aluminum matrix composite reinforced with 7 % Silicon carbide and 3.5 % graphite. The hybrid composite was machined using 27 brass tools with Ø = 3.97 mm. Different pulse on-times (ton), pulse off time (toff) and peak current values (Ip) were used for each electrode.[26]

Jinfeng Leng , they found experimentally that the effect of graphite particles with volume fraction 3.7% on machinability and mechanical properties of Silicon carbide /Aluminium composites were investigated. Results showed that the machinability was improved greatly with the increasing volume fraction of graphite particles. When the volume fraction of graphite particles was 7%, the tool life was prolonged by 130%, and the tensile strength and elastic modulus of Silicon carbide /Graphite/Aluminium composite were 365 MPa and 144 GPa, respectively. The presence of flake graphite particle acted as solid lubrication and promoted chip formation during cutting, resulting in an improved machinability.[27]

A Pramanik, they studied on the electrical discharge machinability of aluminium 6061 in terms of material removal rate, surface finish, kerf/slit width and wear of wire electrode. Concluded that the longer pulse on time generates more heat and facilitates the removal rate of material. Similar to any other materials, the increase of pulse on time increases the removal rate of material for 6061 aluminium alloy. The contribution of wire tension on the removal rate of material is negligible. Though the wire tension does not affect appearance of the machined surface, the surface roughness is found to decrease with the increase of wire tension.[28]

S.Sarkar , they studied wire electrical discharge machining of gamma-titanium aluminide alloy. The process has been successfully modeled using additive model. The predicted response parameters from the model agreed quite well with that of the experimental result. Based on the developed model influence of the various process parameter on the machining criteria was observed. It was noted that both surface roughness as well as dimensional deviation is independent of the pulse off time. This aspect is very important as under certain critical machining condition pulse off time can be varied as per requirement to achieve better stability and accuracy without affecting the dimensional accuracy and surface finish significantly. [29]

C. Velmurugan, they have done Experimental investigations on machining characteristics of Aluminium 6061 hybrid metal matrix composites. objective of this work was to investigate the effect of parameters like Current(I), Pulse on time(T), Voltage(V) and Flushing pressure(P) on metal removal rate (MRR),tool wear rate as well as surface roughness(SR) on the machining of hybrid Aluminium 6061 metal matrix composites reinforced with 10% Silicon carbide and 4% graphite particles. Concluded that Metal removal rate of the composite increases with increase in current, pulse on time and flushing pressure of the dielectric fluid while it decreases with increase in voltage. Tool wear rate of the developed composite increases with increase in current and voltage and it decreases with increase in pulse on time and flushing pressure of the dielectric fluid. Surface roughness of the composite during electric discharge machining increases with increase in current, pulse on time, voltage and flushing pressure. [30]

Johny James, they have done experiment for preparation machining and mechanical properties of Hybrid Aluminium Metal Matrix Composite Reinforced with Sic and TiB_2, Concluded that Increase in weight percentage of reinforcement (Silicon carbide 10% &TiB_2 5%) leads to cluster formation.. from wear analysis that TiB2 particles increase the wear resistance behaviour of hybrid aluminium metal matrix. from the machining analysis that % of reinforcement of TiB_2 is the most significant factor on surface roughness and its contribution is 38.86 %. The addition of TiB_2 reinforcement increases surface roughness value. Low cutting speed, high depth of cut and increased weight % of TiB_2 reinforcement causes as high tool wear. [31]

Akash Nag, they worked on tangential abrasive water jet (AWJ) turning of hybrid aluminium matrix composite fabricated by electromagnetic stir casting technology, consisting A359 aluminium alloy as base matrix and 2% B4C and 2% Al2O3 as reinforcing particles with final work piece diameter of 14.5 mm. The influence of abrasive mass flow rate within 100–400 g/min using two different abrasive grains—olivine and Barton garnet concluded that

AWJ technology can be successfully used for the preliminary rough turning of rotational HMMC parts by eliminating the problem of uneconomic tool wear associated with conventional machining of these materials. The abrasive mass flow rate, one of the principal technological factors of the AWJ process, has a significant effect on the turning results in terms of material removal rate. [32]

G.Ramesh, they have done experimental investigation on Influence of process parameters in machining the Hybrid Aluminum metal matrix composites by using Wire cut EDM process and concluded that Hybrid composites shows high hardness due to hard phase silicon carbide and boron carbide particulates embedded uniformly in aluminium 7075 based matrix Hybrid Aluminium metal matrix composite. Sample with 7 % Silicon carbide and 3% weight Boron carbide composition shows good machining characteristics. The input parameters influencing the machining are pulse on time, pulse off time and current. Material removal rate decreases due to the addition of Silicon carbide and Boron carbide reinforcement in the composite materials. [33]

N Radhika, they have done work on optimisation of Machining parameter of an aluminium hybrid metal matrix composite by statistical modelling method and concluded that feed, speed and depth of cut are contributing to surface finish as well as work piece surface temperature in the order of importance listed. The effectiveness of using Taguchi parameter design as an efficient method for determining the optimum turning parameter to achieve lower surface roughness and work piece surface temperature S/N ratio obtained for different levels shows feed as the dominant factor influencing machining of hybrid composites and the same is validated by results of ANOVA. A major finding in this work establishes that there is an increase in the surface roughness of hybrid composites with increasing feed and depth of cut, but the surface roughness decreased with increase in cutting speed. The work piece surface temperature has risen with increase in speed, feed and depth of cut. [34]

Ferial Hakami, they have done experiment on Tool wear and surface quality of metal matrix composites due to machining and concluded that Cutting speed has the highest effect on tool wear among the machining parameters. The tool wear increased with increasing the cutting speed in all the cutting conditions. The feed rate is the second influential machining parameter on tool wear. Higher feed rates produced a higher tool wear. The coated tool performs better than the uncoated one in terms of low tool wear and improved dimensional accuracy. Increasing of reinforcement volume fraction increases tensile strength and hardness of MMC material and cutting tool's flank wear. The increase in particle volume fraction has negative effects on roughness. [35]

Vibu Nanthan.M, they studied on Machinability Studies of Turning Aluminium/Silicon carbide/Boron carbide Hybrid Metal Matrix Composites using orthogonal array with ANOVA Analysis and concluded that surface roughness and cutting force improved together using the said method. Predicted and experimental values are very close together. And Tool flank wear was caused by abrasive nature of hard particles in work piece. [36]

5. CONCLUSIONS

From the above literature review it is clear that there is essential need to select appropriate machining process for effective machining of hybrid aluminium metal matrix composites. From the published work it is clear that hybrid aluminium metal matrix composite is one of the major problem which resists its wide spread application in industry. From few literatures Non-conventional machining methods like wire cut Electrical Discharge machining found suitable for machining hybrid metal matrix composites. The weight percentage of reinforcements is the most significant factor which have maximum influence on surface roughness of hybrid metal matrix composites followed by speed, feed, depth of cut, with respect to cutting force applied. The distribution of reinforcements in base matrix can be studied by using scanning electron microphotograph technique. Hybrid composites are better substitutes to reinforcement metal matrix composites with single reinforcement material as these shows improved wear resistance due to combined reinforcement's properties.

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