IMPROVEMENT OF SURFACE QUALITY OF Al- METAL MATRIX COMPOSITE: A REVIEW

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ABSTRACT

This review article is based on the industrial demand of the present scenario in the area of machining of the metal matrix composites. This paper has been presented an overview of the machining of the Al Metal Matrix Composites (Al-MMC). Metal matrix composite is the right choice for manufacturing sectors due to the properties of the materials such as low weight, good strength, and corrosion free. Machining of the Al-MMC by the selected cutting tools and extra material is moved out from the surface of the workpiece in the form of chip and convert into desired size and shape by controlling of parameters i.e. cutting speed, feed and depth of cut. In machining surface finish is desired so that cutting tool plays a major role. Due to the abrasive surface of the composite materials cutting tools may be wearing in very less time so that researchers and industries are doing more effort in this direction. There are various tools may be used like carbides either plain or coated for machining of the MMC. Surface quality of the AL-MMC can be achieved by the proper controlling of the parameters and maintain the condition of the tools. After completing the machining processes analysis can be done for the experimental collected data. For the optimization purposes various techniques may be used. Some techniques can be used such as ANN, analysis of variance and Multilayer perceptron model will be construct with back-propagation type algorithm.

Keywords: Metal Matrix Composites, Machining, cutting tools, non-traditional machining methods, cutting speed.

1. INTRODUCTION

Machining of the metal matrix composites (MMC) is the challenging task for the researchers. Advanced engineering materials i.e. MMC applications are in various engineering sectors like aerospace, automobile and marine etc. so that quality machining of MMC is required. For conventional machining of the workpiece i.e. MMC, hard material tools are required such as polycrystalline diamond (PCD), cermet and coated tungsten carbide (WC), cubic boron nitride (CBN). It has been observed that these tools have used for low speed machining in large quantity. It has also been observed that for the machining of MMC with very less quantity of lubrication but not found any significant research in this direction. It has been investigated of the tool wear and prediction of tool life with feed rate and cutting speed at minimum depth of cut can be estimated compressively. Hard metallic composite surfaces have difficult to machine in dry condition and badly affected tool surfaces as well as quality of machined surface. According to the literature survey of the machining of the composite materials, cutting force is mainly affected by increased depth of cut and feed rate for composite materials. It has been observed that the on the rough surface of the MMC forces will be high with increase in feed rate and depth of cut, which increases power required for machining in all cutting conditions. It has also been observed that the damage the notch of the tool was minimum for Al-SiC composite as compared to other advanced metal matrix composite (AMMC) with Al_2O_3 and Al_2O_3 – SiC.

It has been shown that the review article generally shows the machining of the MMC is difficult-to-machine by some common unconventional machining methods used in various manufacturing sectors. During the machining of the abrasive workpiece of the MMC, tools wear might be more which affected the quality of the machining. Built-up edge is formed during the machining process of MMC so that quality of the materials surface would be affected and tool life is reduced due to more wear of the cutting tool notch. Due to more friction between the tool and the MMC the heat affected zone (HAZ) was also more and metallurgical properties may be changed of the MMC. To fulfill the requirement of the market unconventional machining processes (UMP) are more suitable. Desired size and shape of the MMC was obtained without chip formation by the UMP. There is no contact between tool and the workpiece i.e. MMC so that no tool wear, less friction force and finally better surface finish on the workpiece.

2. LITERATURE REVIEW

S.No.	Authors	Machining process	Optimization/Analysis process	Materials	Output quality characteristics
1	Kundu et. al. [1]	Grinding of alumina wheel	Scanning Electron Microscope [SEM]	Ti-6Al-4V	S.R .and MRR
2	Yang et al. [2]	Mass finishing, Particle dynamics; Polyurethane	DEM	Aluminium alloy wheel hub	MRR model
3	Yang et. al. [3]	Magnetic abrasive finishing	ANSYS Maxwell 14.0	6061 aluminium alloy tube	Material removal ratio
4	Bhardwaj A.R. [4]	High speed steels, Satellite, cemented carbides tool cutting	Review	Aluminum metal matrix composite [Al-MMC]	Cutting speed
5	Gore et al . [5]	Review finding	Wire EDM	MMC	Modeling is done for process of Machining
6	Manna et. al. [6]	RSM BBD	Wire EDM	Particulate Al/SiC-MMC	Surface roughness, surface integrity, MRR
7	Bostan et al. [7]	Treatment of Cryo-ageing	SEM, XRD, EDS, MAP	AA2014–SiC MMC	Metolographic behavior and hardness
8	Bikramjit et al. [8]	Friction stir welding	review	Different types of Al-MMC	tool wear
9	Sato et. al. [9]	Magnetic field assisted finishing with alumina abrasiv	Process modelling	aluminium alloy	material removal rate [MRR]
10	Gupta et al. [10]	LAM	Forces observations during cutting	Al/ Al2O3	Wear of Tool, surface roughness
11	Wang et al. [11]	Laser Assisted Machining	SEM of chips	YSiAlON glass	MRR
12	Palanivel R et al. [12]	Ultrasonic Machining	Vibration cut	Al/45 percent SiCp	Force during cutting, formation of chip and observation of shape of chips, material removal rate, wear of tool, surface roughness
13	Palanivel R et al. [13]	Ultrasonic Machining	Vibration	Si-C Mono-crystals	Material Removal Rate
14	Yadav et al. [14]	Ultrasonic Machining	Vibration	Al2O3 LaPO4	MRR, drilled hole geometry. Acoustic emission

15	Stein [15]	Electric Discharge Machining	TOPSIS method	Al/24% SiC	Tool Wear Rate, Surface roughness and MRR
16	Zhakiah et al. [16]	Electric Discharge Machining	Effect of Medium and Gap	MMC Al/SiC	SR , MRR
17	Gore et al. [17]	Electric Discharge Machining	EDS, XRD	Ti–6Al–4V	TWR, MRR, surface quality
18	R. Khorshidi et. Al .[18]	XRD, EDS, FESEM	Mg_2 Si modification	Al−Mg_2Si composite	More temperature and shear strength
19	A Zulfia et. al.[19].	Stir casting	SEM-EDS, XRD	Al-Si-Mg alloy, SiC, composites	mechanical properties
20	Gurupavan H R et. al. .[20]	Wire-EDM	Artificial Neural Network	MMC	S. R.
21	Max Stein [21]	MAF	high power industrial lasers (~500 MW)	Yttrium Aluminum Garnet (YAG) Ceramics	Tool effects on flatness and roughness
22	S.K.Lalmuan et. al. .[22]	Turning, Wire-EDM	Review for optimization	Hybrid composites	Surface roughness, MRR
23	Adalarasan et al. [23]	Laser Assisted Machining	Pulsing frequency	Al6061/SiCp/Al_2O_3	Surface smoothness, cut edge slope kerf width.
24	Chang and Kuo [24]	Laser Assisted Machining	TM [Taguchi's Method]	Al/ Al_2O_3	surface integrity and wear of tool
25	Rajkumar et al. [25]	Electro-Chemical Machining	RSM	Al/B_4 C	Surface roughness, MRR

3. LITERATURE REVIEW SUMMARY

Many research papers have been used process parameters, materials, instruments, dielectric fluids, workpiece etc. The procedure displaying of WEDM / EDM is found since 1973 [5,6,15,18,19,20,21,22]. The model is mechanical, thermo-physical [12, 13, 14], thermo-electrical [10, 11, 23, 24], electro-mechanical. Quantities of analyses were done to explore the impact of procedure parameters on material expulsion rate, surface completion [5, 9, 19, 22, and 25] and portrayal. Diverse methodologies utilized as FDM, FEM, and FVM to unravel the models. Programming instruments utilized were ANSYS, ABAQUS, MATLAB, and so on [5, 9, 14, 20, and 23]. Researchers on the basis of the past record enhance their knowledge and uses of process and its parameters to investigate the future requirements of the industries. The models created are numerical [1, 3, 21, 22], expository [2, 5], experimental, semi-observational for EDM/WEDM process. The vast majority of the distributed research work has been done in sinking EDM process. It has been observed that no research work is done on WEDM yet [19].

4. FUTURE SCOPE

A lot of researches have been completed on EDM. No machining work has been done on MMC through WEDM. Research possibilities are in the area of:

1. Modeling of Metal Matrix Composites as work-piece.

2. Procedure modeling of Wire-EDM.
3. Study of interaction between electrode, work-piece, and plasma for Wire-EDM.
4. Optimal input parameters of Wire-EDM.
5. Details of hybrid tools.
6. Maintain surface smoothness and quality by controlling of tools.

5. CONCLUSION

Point of this article is to feature real work examines for Wire-EDM for Metal Matrix Composites. Past research considers about concentrated on procedure displaying, input parameters, metals of anodes/instrument components, working medium, improvement of process, and so on. The paper is mainly highlighting about purpose of Wire-EDM is considered as main target.

REFERENCES

[1] Kundu P.K., Mukhopadhyay M, "Optimization of dressing infeed of alumina wheel for grinding Ti-6Al-4V", *Materials and Manufacturing Processes*, 33, pp. 1453-1458, 2018.

[2] Li W., Li X., Yang S., Hao Z., Shi H., "Study on polyurethane media for mass finishing process- Dynamic characteristics and performance", *International Journal of Mechanical Sciences*, pp. 138-139, 2018.

[3] Yang S., Li W., Li X., "A newly developed media for magnetic abrasive finishing process- Material removal behavior and finishing performance", *Journal of Materials Processing* Technology, pp. 20-29, 2018.

[4] Bhardwaj Ajay R., "Machining of Metal Matrix Composite – A Review", *IJARIIT*, 2018.

[5] Gore A., "Wire electro discharge machining of metal matrix composites - A review", *International Conference on Materials Manufacturing and Design Engineering*, 2018.

[6] Manna A., Kumar H., Kumar R., "Modeling of Process Parameters for Surface Roughness and Analysis of Machined Surface in WEDM of Al/SiC-MMC", *Transactions of the Indian Institute of Metals,* 231 – 244, 2017.

[7] Bostan B., Aksöz S., "Effects of Ageing and Cryo-ageing Treatments on Microstructure and Hardness Properties of AA2014–SiC MMCs", *Transactions of the Indian Institute of Metals,* pp. 2035 – 2042, 2018.

[8] Bist A., S. Bikramjit, "A review of tool wear prediction during friction stir welding of aluminium matrix composite", *Transformation Nonferrous Materials Soc. China*, 2018.

[9] Sato T., Kum C.W., Guo J, Liu K., Butler D., "A novel media properties-based material removal rate model for magnetic field-assisted finishing", *International Journal of Mechanical Sciences*, pp. 189-197, 2018.

[10] Gupta A., Nautiyal P., Seal S, Agarwal A., Boesl B., "Reactive wetting and filling of boron nitride nanotubes by molten aluminum during equilibrium solidification", *Acta Materialia*, pp.124-131, 2017.

[11] Wang H., Ning F., Fernando P.K., Cong W., "A mechanistic ultrasonic vibration amplitude model during rotary ultrasonic machining of CFRP composites", *Ultrasonics*, pp. 44-51, 2017.

[12] Palanivel R., Ganesh Babu B., Selvakumar I.D.S., "Development of stainless steel particulate reinforced AA6082 aluminum matrix composites with enhanced ductility using friction stir processing", *Materials Science & Engineering A*, pp. 36- 43, 2017.

[13] Palanivel R., Ganesh Babu B., Selvakumar I.D.S., "Characterization of molybdenum particles reinforced Al6082 aluminum matrix composites with improved ductility produced using friction stir processing", *Materials Characterization*, pp. 13-22, 2017.

[14] Yadav P. C., Singh D.K., Ahmad S.G. S., "Optimization of Process Parameters affecting Surface Roughness in Magnetic Abrasive Finishing Process", *Materials and Manufacturing Processes*, pp. 15 – 23, 2017.

[15] Stein M., Abrasive- Magnetic-Finishing-with-Magnetic-Hybrid-Tools, compressed, 2017.

[16] Zhakiah T., Zulfia A., Dhaneswara D., "Characteristics of Al-Si-Mg Reinforced SiC Composites Produced by Stir Casting Route", *IOP Conference Series*, pp. 202 – 210, 2017.

[17] Gore A., "Wire electro discharge machining of metal matrix composites - A review", *International Conference on Materials Manufacturing and Design Engineering*, 2018.

[18] Bist A., S. Bikramjit, "A review of tool wear prediction during friction stir welding of aluminium matrix composite", *Transformation Nonferrous Materials Soc. China*, 2018.

[19] Stein M., Abrasive- Magnetic-Finishing-with-Magnetic-Hybrid-Tools, compressed, 2017. [20] Devegowda T.M., Gurupavan H.R., Ugrasen G., Ravindra H.V., "Estimation of Machining Performances in WEDM of Aluminium based Metal Matrix Composite Material using ANN", *Materials Today Proceedings*, pp.10035-10038, 2017.

[21] Honarbakhsh-Raouf A., Khorshidi R., Mahmudi R., "Microstructural evolution and high temperature mechanical properties of cast Al–15Mg 2 Si– x Gd in situ composites", *Journal of Alloys and Compounds*, pp. 18-28, 2017.

[22] Das S., Lalmuan S.K., Tamang S.K., Chandrasekaran M., "Machining Investigation on Hybrid Metal Matrix Composites- A Review", Materials Today Proceedings, pp. 8167-8175, 2017.

[23] Cheng J.F., Li G.R., Li C.Q., Wang H.M., "The influence of cryogenic-aging circular treatment on the microstructure and properties of aluminum matrix composites", *Journal of Alloys and Compounds*, pp. 1930-1945, 2017.

[24] Sidpara A., Nagdeve L., Jain V.K., Ramkumar J., "On the effect of relative size of magnetic particles and abrasive particles in MR fluid-based finishing process", *Machining Science and Technology, pp.* 493-506, 2017.

[25] Manna A., Kumar H., Kumar R., "Modeling of Process Parameters for Surface Roughness and Analysis of Machined Surface in WEDM of Al/SiC-MMC", *Transactions of the Indian Institute of Metals*, 231 – 244, 2017.