International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-2, December 2019

Various Non-Conventional Machining methods for Aluminium Metal Matrix Composites

Jaspreet Singh, Sanjeev Saini

Abstract— The work reviewed here an overview of the current investigates about the machining of Aluminum metal matrix composite (MMC) which is major concern now a day's industry. There is an increase demand of the development of advanced metals for many industrial applications, to complete such demands metal matrix composites are the right solution. Metal Matrix Composites (MMCs) have higher strength to weight ratio and their properties may be tailored as per the industrial requirements. The main purpose of machining is to produce a product of desired shape and size with specific quality and surface finish by removing a material in the shape of chips and it is affected by cutting parameters like feed rate and depth of cut also the selection of cutting tool plays a major role. However, MMC's are highly abrasive and tools can wear rapidly, machining of these materials attracted researchers and industrial community a lot. So various tooling systems like Carbides, either plain or coated for tool of milling, drilling, and non-traditional methods of machining are also use to achieve the high durability, dimensional tolerances, functional requirements and surface quality of such materials after machining of MMCs. After machining analysis of the experimental data collected from various combination of analysis, methods are to be uses as ANN artificial neural network, analysis of variance (ANOVA) and TELBO techniques and Multilayer perceptron model will be constructed. On completion of the test, the techniques are to be used in authenticate the result found and to expect the behavior of the system.

Keywords: Cutting tools, cutting speed, Machining, MMC, non-traditional machining, Reinforcement, Wire electric discharge machining.

I. INTRODUCTION

Metal matrix composites are really hard to machine materials so researchers are consistently working on it to increase the machinability of MMC and to enhance the tool life. It is also recognized that their machining is not totally accurate with traditional machining methods. The use of MMC in some areas of engineering is increasing significantly. It is also recognized that their machining behavior is not completely undeclared. In recent years, in many areas of engineering MMC has grown considerably. MMC, polycrystalline tools (PCD), conventional polycrystalline diamond (PCD), cermet and tungsten carbide machining used in industry widely.

Revised Manuscript Received on December 30, 2019.
* Correspondence Author

Jaspreet Singh*, is Research Scholar and currently pursuing doctorate degree program in Mechanical Engineering in I.K.G. Punjab Technical University Kapurthalla, Punjab, India, E-mail: jassi21387@gmail.com

Dr. Sanjeev Saini is currently working as Assistant Professor in Department of Mechanical Engineering, DAVIET, Jalandhar, Punjab, India, E-mail: sanjudaviet@gmail.com

Although some ethics are dispersed, work has been observed in the use of composite materials under much lower lubrication conditions, but no significant repetition has been recorded in this area.It is interested to see the composition of metal; they will be in charge of the reinforcements made even more difficult. The force for cut increases with the depth of the cut and the speed of advance, finally the power goes automatically under all conditions. This article by synthesis confirms that MMC is very difficult to handle. Along with this, it has also been indicated that some metal matrix components are more usable than those of the most important type in terms of reinforcement, matrix and heat treatment can be inconvenient to be machined. It is important that the MMC be use the conditions of interest and that they be neither use nor decontaminate. The basic actions, which are the object of the tool, are quite pretentious, plus the abrasive material will be wear resistant. Therefore, by increasing hardness, irregularity and volume fraction, the reinforcement phase before the matrix resistance of the abrasiveness of the metal compounds increases. Different types of properties (mechanical, electrical, synthetic, electro-substance, light, etc.) for the assortment will change. Prescribed details of abrasive reinforcement during the rapid use operation. For composite materials (MMC), hard materials such as cubic boron nitrile (CBN), polycrystalline diamond (PCD), cermet and tungsten carbide are used in conventional machining analysis methods.

II. LITERATURE REVIEW

After summarizing the table below the researchers have done lot of work in the area of material removal, chipping size calculation metal depositing in the form of powder by means of some advanced methods, Non-conventional grinding, finishing and little part is of cutting the complicated shapes. All the operations have been performed to analyses the final results of Metal removal rate, chip size, material surface finish and tool wear rate [7,11,14,15,16,19,21,31]. The procedures showing all the working parameters and work piece used for the different researchers. The method of analysis is generally used RMS, ANN, GA, Taguchi's Method, and BBD. Sometimes software like MATLAB, ANSYS Maxwell, ABAQUS and MINITAB etc. were used to analyses the findings. Some Miscellaneous methodologies used such as finite element method, finite volume method and finite difference method to find out new models [2,3,7,11,13,24,30]. So we concluded that most of the researcher have focused on material removal along with some researchers have coted some material with magnetic abrasive particle as wire magnetic and induction free abrasive wire sawing (MIFAWS) is one of the method by which Chunyan

Yao et al have prepared magnetic abrasive particle layer on the wire surface and then thickness was calculated for to find out how much magnetic abrasive particle coating formed on wire surface.

SNo.	Authors	Material	Machining process	Analysis /optimization process	Output parameter response
1. 1 .	Chunyan Yao et al.[1]	(MAPL) Magnetic abrasive particle layer	MIFAWS	Analysis by MATLAB	Thickness calculated for coating formed on the surface of wire
2.	A-Cheng Wang et al.[2]	complex-hole on samples of SKD-11 steel	AFM with Silicon and gel mixed with abrasive grains	numerical analysis by MATLAB	surface roughness
3.	Kheelraj Pandey, Pulak M Pandey.[3]	Mono-crystalline silicon wafer Si	Chemical oxidizers alumina slurry in Double Disk Magnetic Abrasive Finishing machine	Analysis of Variance (ANOVA)	surface finish
4.	Manish Mukhopadhyay et al.[4]	Ti-6Al-4V	dressing infeed of alumina wheel for grinding	SEM	MRR And surface roughness
5.	Xiuhong Li et al.[5]	aluminium alloy wheel hub	Mass finishing, Particle dynamics; Polyurethane	DEM	MRR model
6.	Wenhui Li .[6]	6061 aluminium alloy tube	magnetic abrasive finishing	ANSYS Maxwell 14.0	material removal ratio
7.	Chun Wai Kum .[7]	aluminium alloy	Magnetic field assisted finishing with alumina abrasives	Process modelling	material removal rate
8.	Ashish BIST et al.[8]	Different types of aluminium matrix composites	friction stir welding	review	tool wear
9.	Sinan Akso¨z et al.[9]	AA2014–SiC MMC	Cryo-ageing Treatment	SEM, XRD, EDS, MAP	hardness and metolographic behavior
10.	AjayR.Bhardwaj et al .[10]	Aluminum metal matrix composite	High speed steels, Satellite, cemented carbides tool cutting	review	cutting speed
11.	Abhay S. Gore et al .[11]	MMC	Wire Electric Discharge Machining (WEDM)	findings and summery of review	Modeling of Machining process
12.	Harmesh Kumar [12]	Particulate Al/SiC-MMC	WEDM	RSM BBD	Surface roughness, surface integrity, MRR
13.	Gurupavan H R et. al. .[13]	MMC	WEDM	ANN	Surface roughness
14.	S.K.Lalmuan et. al. .[14]	Hybrid composites	Turning and WEDM	Optimization review	material removal, Surface roughness
15.	A Zulfia et. al.[15].	Al-Si-Mg alloy, SiC, composites	Stir casting method	SEM-EDS, XRD	mechanical properties
16.	Max Stein [16]	Yttrium Aluminum Garnet (YAG) Ceramics	Magnetic Abrasive Machining	high power industrial lasers (~500 MW)	effect of tools on flatness and roughness
17.	R. Khorshidi et. Al .[17]	Al−Mg2Si composite	FESEM, EDS, XRD	Mg2Si modification	High temperature shear strength
18.	Mahapatra and Patnaik [18]	Al Metal matrix composite	Electric Discharge Machining (EMD)	Taguchi's Method, GA	Surface roughness, MRR
19.	Debabrata et al. [19]	Al MMC	EMD	ANN.GA	Surface roughness, MRR
20.	Jabbaripour et al. [20]	Ti–6Al–4V	EDM	EDS, XRD	TWR, MRR, surface quality
21.	Liu [21]	MMC Al/SiC	EDM	Effect of Medium and Gap	SR , MRR
22.	Bhuyan et al. [22]	Al/24% SiC	EDM	TOPSIS method	TWR, MRR and Surface roughness
23.	Majeed et al. [23]	Al2O3 LaPO4	Ultra sonic machining	Vibration	MRR, Drilled hole geometry. Acoustic emission
24.	Liu et al. [24]	SiC Monocrystals	Ultra sonic machining	Vibration	Material Removal Rate
25.	Zhou et al. [25]	Aluminum 45%SiCp	Ultra sonic machining	Vibration	Cutting force required, MRR, Tool wear rate , Chip shape
26.	Lei et al. [26]	YSiAlON glass	Laser Assisted Machining (LAM)	Scanning Electron Microscopy	Material Removal Rate
27.	Wang et al. [27]	Al and Al2O3	Laser Assisted Machining (LAM)	Effect of cutting forces	TWR ,Surface Quality
28.	Chang and Kuo [28]	Al/ Al2O3	LAM	Taguchi's method	Tool wear, surface integrity
29.	Adalarasan et al. [29]	Al6061/SiCp/Al2O3	LAM	Pulsing frequency	Surface finish, cut edge slope kerf width.

30.	Rajkumar et al. [30]	Al/B4C	Electro chemical Machining (ECM)	Root Mean Square method	Surface finishing, MRR
31.	Senthilkumar et. [31]	Aluminum MMC	Electro chemical Machining (ECM)	Taguchi method	Material Removal Rate
32.	Phipon and Pradhan [32]	Aluminum MMC	ECM	Root Mean Square method (RMS)	Radial overcut and Heat Affected Zone (HAZ)

Process was analyzed by MATLAB and results are discussed in detail for developing new areas of research [1]. The model used for machining is thermo-physical [24,25,26], electro-mechanical and thermo-electrical [27,28,29,30]. EDM and WEDM process is used for some complicated and tough to machine work pieces and for these machines the numerical model is created to analyses the process parameters for optimization [4,6,14,17], and for semi observational data [19,20]. After machining and collecting the data the impact of input parameters on work for the response on surface completion, MRR, portrayal and expulsion rate etc. was calculated [7,11,14,15,16,19,21,31]. For endeavoring to enhance those procedure parameters new set up has been established for database which is utilized for future research. Researchers have done lot of work in different non-conventional areas to enhance the knowledge and likewise looked into some investigations to done in past few years. If we see the research work done till date the majority of disseminated research work have been done on die sinking EDM and there is very less amount of work is done in the field of Wire EDM yet. So, there is scope to do work in this particular field [16].

III. FUTURE SCOPE

In past years researchers have done work on materials like steel ductile iron and some ceramics with the help of EDM. But sometimes there are some complicated shapes which not easy to manufacture, so in this case Wire EDM is one of the best suited non-conventional machining methods. Researchers have not done much work in this particular area so likewise there is future scope and research possibilities in this area. Some of the possibilities are:

1. Analysis of interaction plots between electrode wear, MRR and surface finishing of work-piece (MMC) by WEDM.
2. Optimum combination of process parameters of WEDM.
3. Describe hybrid tools.
4. Control effect of tools on flatness and roughness.

IV. CONCLUSION

At last, it is apparent from an examination of the writing that exploration is proceeding into systems for improving the quality of MMCs even more. As this quality increment is accomplished, MMCs will turn out to be considerably increasingly hard to machine and it is subsequently imperative that the machining conduct of these materials is comprehended and improved quite far so as to adapt to what no uncertainty will be significantly more prominent difficulties later on. In spite of the fact that the work evaluated here shows that an important begin has been made towards this objective, there remains a significant measure of work to be performed before the machining conduct of these materials is completely comprehended. The recent developments in the composite parts often require post-mould machining to meet dimensional tolerances, near net shape manufacture. Particularly the reinforcement composition of particles like Silicon Carbide (SiC), alumina (Al2O3) and boron carbide (B4C) in MMC is less than 45%. Mostly Silicon Carbide (SiC) as reinforced particle is used in the matrix of aluminum along with some other combinations like titanium matrix with boron carbide (B4C) and alumina and magnesium alloys as matrix and alumina (Al2O3) as reinforced particle. When some metal matrix composite is made by adding these hard particles there is need to characterize the machine tool for machining of such material. It is also necessary to select required tool material to enhance the tool life and machinability. Tool selection will make impact on machining conditions and MRR of work. The point of this research is to enhance the future opportunities for WEDM in case of aluminium MMCs. Past researcher have considered about procedure for displaying process parameters for machining, materials of anodes/instrument, work material used, dielectric media like dry or wet (gas, mixture of water and kerosene etc.), progress of procedure parameters, and so on. This present review paper thinks about reasons that displaying about WEDM is considered as prime goal.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the technical support provided by IKG Punjab Technical University, Kapurthala, India and Department of Mechanical Engineering at DAVIET, Jalandhar (Punjab), India for carrying out this work.

REFERENCES

1. C. Yao, W. Zhang, K. Li, X. Xu, H. Li, Study on the formation mechanism of the magnetic abrasive particle layer on the surface of saw wire in magnetic induction-free abrasive wire sawing, Powder Technology 327 (2018) 163-169.
2. A.C. Wang, K.-C. Cheng, K.-Y. Chen, Y.-C. Lin, A Study on the Abrasive Gels and the Application of Abrasive Flow Machining in Complex-hole Polishing, Procedia CIRP 68 (2018) 523-528.
3. K. Pandey, P.M. Pandey, Use of chemical oxidizers with alumina slurry in Double Disk Magnetic Abrasive Finishing for improving surface finish of Si (100), Journal of Manufacturing Processes 32 (2018) 138-150.
4. M. Mukhopadhyay, P.K. Kundu, Optimization of dressing infeed of alumina wheel for grinding Ti-6Al-4V, Materials and Manufacturing Processes 33(13) (2018) 1453-1458.
5. X. Li, W. Li, S. Yang, Z. Hao, H. Shi, Study on polyurethane media for mass finishing process: Dynamic characteristics and performance, International Journal of Mechanical Sciences 138-139 (2018) 250-261.
6. W. Li, X. Li, S. Yang, W. Li, A newly developed media for magnetic abrasive finishing process: Material removal behavior and finishing performance, Journal of Materials Processing Technology 260 (2018) 20-29.
7. C.W. Kum, T. Sato, J. Guo, K. Liu, D. Butler, A novel media properties-based material removal rate model for magnetic field-assisted finishing, International Journal of Mechanical Sciences 141 (2018) 189-197.
8. J.S.S. Ashish BIST, Bikramjit SHARMA, A review of tool wear prediction during friction stir welding of aluminium matrix composite, in: s. direct (Ed.) Transformation Nonferrous Materials Soc. China, 2018.

9. S. Aksöz, B. Bostan, Effects of Ageing and Cryo-ageing Treatments on Microstructure and Hardness Properties of AA2014–SiC MMCs, Transactions of the Indian Institute of Metals 71(8) (2018) 2035-2042.
10. D.A.M.V. Ajay R. Bhardwaj MACHINING OF METAL MATRIX COMPOSITE: A REVIEW, IJARIIT (2018).
11. N.G.P. Abhay S. Gore, Wire electro discharge machining of metal matrix composites: A review, 2nd International Conference on Materials Manufacturing and Design Engineering, International Conference on Materials Manufacturing and Design Engineering, 2018.
12. H. Kumar, A. Manna, R. Kumar, 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 71(1) (2017) 231-244.
13. H.R. Gurupavan, T.M. Devegowda, H.V. Ravindra, G. Ugrasen, Estimation of Machining Performances in WEDM of Aluminium based Metal Matrix Composite Material using ANN, Materials Today: Proceedings 4(9) (2017) 10035-10038.
14. S.K. Lalmuan, S. Das, M. Chandrasekaran, S.K. Tamang, Machining Investigation on Hybrid Metal Matrix Composites- A Review, Materials Today: Proceedings 4(8) (2017) 8167-8175.
15. A. Zulfia, T. Zhakiah, D. Dhaneswara, Sutopo, Characteristics of Al-Si-Mg Reinforced SiC Composites Produced by Stir Casting Route, IOP Conference Series: Materials Science and Engineering 202 (2017).
16. M. Stein, Magnetic-Abrasive-Finishing-with-Hybrid-Magnetic-Tools.compressed, (2017) (2017).
17. R. Khorshidi, A. Honarbakhsh-Raouf, R. Mahmudi, Microstructural evolution and high temperature mechanical properties of cast Al–15Mg 2 Si– x Gd in situ composites, Journal of Alloys and Compounds 700 (2017) 18-28.
18. Mahapatra, S.S. & Patnaik, A. International Journal Advanced Manufacturing Technology (2007) 34: 911.
19. Debabrata Madal, Surjya K. Pal, Partha Saha (2007), “Modeling of electrical discharge machining process using back propagation neural network and multiobjective optimization using non-dominating sorting genetic algorithm-II”, Journal of material processing technology, pp.154-162.
20. Jabbaripour, Behzad et al. “INVESTIGATING THE EFFECTS OF EDM PARAMETERS ON SURFACE INTEGRITY, MRR AND TWR IN MACHINING OF Ti–6Al–4V.” (2012).
21. U.K. Jinghang Liu, Jonathan Coleman, Bea Fernandez, Pablo Rodriguez, Sumsun Naher, Dermot Brabazon, Graphene oxide and graphene nanosheet reinforced aluminium matrix composites: Powder synthesis and prepared composite characteristics, JMADE 1232 (2016).
22. Bhuyan, Rajesh Kumar and Bharat Chandra Routara. “Optimization the machining parameters by using VIKOR and Entropy Weight method during EDM process of Al–18% SiCp Metal matrix composite.” (2016).
23. Majeed, Majed A. et al. “Ultrasonic machining of Al2O3/LaPO4 composites.” (2008).
24. J. Guo, C.W. Kum, K.H. Au, Z.E.E. Tan, H. Wu, K. Liu, New vibration-assisted magnetic abrasive polishing (VAMAP) method for microstructured surface finishing, Optics Express 24(12) (2016).
25. Zhou, Lixing et al. “Simulation of swirling combustion and NO formation using a USM turbulence-chemistry model.” (2003).
26. Lei, Shuting et al. “Deformation mechanisms and constitutive modeling for silicon nitride undergoing laser-assisted machining.” (2000).
27. F. Ning, H. Wang, W. Cong, P.K.S.C. Fernando, A mechanistic ultrasonic vibration amplitude model during rotary ultrasonic machining of CFRP composites, Ultrasonics 76 (2017) 44-51.
28. Tzeng, Wen-Hsien et al. “Resistive switching characteristics of multilayered (HfO2/Al2O3)n n = 19 thin film.” (2012).
29. Adalarasan, R. and M. Santhanakumar. “RESPONSE SURFACE METHODOLOGY FOR EFFECTIVE LUBRICATION AND REDUCED TOOL WEAR IN TURNING EN24 STEEL.” (2016).
30. Yuvaraj, N. et al. “Fabrication of Al5083/B4C surface composite by friction stir processing and its tribological characterization.” (2015).
31. Selvakumar, V. S. et al. “Evaluation of Mechanical and Tribological Behavior of Al–4 %Cu–x %SiC Composites Prepared Through Powder Metallurgy Technique.” Transactions of the Indian Institute of Metals 70 (2016): 1305-1315.
32. Phipon, Ruben and Bidya Banmali Pradhan. “OPTIMIZATION OF ELECTROCHEMICAL DISCHARGE MACHINING PROCESS USING GENETIC ALGORITHM.” (2012).
33. Kamyar Shirvanimoghaddam a, Salah U. Hamimb, Mohammad Karbalaei Akbari c, Seyed Mousa Fakhrhoseini a, Hamid Khayyam a, Amir Hossein Pakseresht d, Ehsan Ghasali d, Mahla Zabet e, Khurram Shahzad Munir f, Shian Jia g, J. Paulo Davim h, Minoo Naebe, Carbon fiber reinforced metal matrix composites: Fabrication processes and properties, Composites: Part A (2017).
34. M.E.S.W.G.W.T. Grund, Joining of material compounds of aluminium matrix composites (AMC) by arc brazing using Al-Ag-Cu system filler alloy, springer (2017).
35. S. Fouladi, M. Abbasi, The effect of friction stir vibration welding process on characteristics of SiO2 incorporated joint, Journal of Materials Processing Technology 243 (2017) 23-30.

AUTHORS PROFILE

Jaspreet Singh is a Research Scholar of I.K. Gujral Punjab Technical University, Kapurthala and currently he is working as an Assistant Professor in the Department of Mechanical Engineering at Lovely Professional University, Phagwara (Punjab), India. He holds M.Tech Degree in Metallurgical Engineering from PEC University of technology, Chandigarh and B.E. in Mechanical Engineering from GZSCET Bathinda, Punjab. He has teaching experience of over 8 years. He has guided 4 M.Tech students in the areas of Non-Conventional Machining Processes and 12 Students at Undergraduate level.

Dr. Sanjeev Saini is currently the Assistant Professor & Controller of Examination in the Department of Mechanical Engineering at DAVIET, Jalandhar (Punjab), India. He holds a PhD Degree from Punjab Technical University, Jalandhar. He has teaching experience of over 22 years. He has guided 4 PhD and 5 students in the areas of Non-Conventional Machining Processes, Residual Stress in Hard Turning and Industrial Engineering etc. He has filed 02 Patents along with he has published 32 papers in several Journals and Conferences of National and International repute.