Turning of Metal Matrix Composites - A Review

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***Abstract*— Metal matrix composites have entered in industry with extreme interest from the automobile and aerospace sectors due to their superior mechanical properties and applications. From several studies it is concluded that there are different types of MMCs available. During last few years, researchers have uncovered many secrets relating to these advanced materials. This paper briefly reviews the turning operations carried on MMCs using uncoated carbide tool and coated tool. Due to the abrasive nature of the reinforcements, MMC is considered as a difficult to cut material. Turning test were performed at various speed, feed rate, depth of cut and percentage of alumina inclusion in MMCs. From most of the studies it has been concluded that poor machinability is due to abrasive nature of the reinforcements and hardness of MMC material. It is also concluded that with increase in the hardness and volume fraction of particle machinability decreases.**

Keywords- MMC; turning, chip formation; tool wear; surface roughness; metal removal rate; cutting forces.

I. Introduction

The modern industries require advanced engineering materials that exhibit superior specific properties at high operating conditions such as high temperature and loads. The major requirements of such advanced materials are high strength/weight ratio, low coefficient of thermal expansion, good fatigue life, hot hardness, wear resistance and corrosion resistance [1]. Such unusual properties can be easily achieved by Metal Matrix Composites (MMCs). Generally, MMCs can be defined as those advanced materials that contain two of more different properties of the constituent materials i.e. one is soft as matrix while other is hard and brittle as reinforcement. The matrices are aluminium, copper like soft metals while reinforcement materials are ceramics like SiO_2 [2, 3], Al_2O_3 [4 - 8], Fe_2O_3 [9], MgO [10 – 12], TiO_2 [13 – 17], ZrO [18, 19], SiC [20 – 27], B_4C [28 – 32], TiC [33- 35], ZrC [36], TiB_2 [37 – 39], Si_3N_4 [40, 41], AlN [42 – 44], BN [45, 46], TiN [47 – 49] or Graphite [50 – 52]. The purpose of matrix into MMCs is to provide the support for reinforcement materials while reinforcements are used to provide the strength to the MMCs. Advancement in technology needs more and more unusual properties of MMCs. Due to this, researchers are combined the two or more than two reinforcement into matrix and such developed MMCs are known as hybrid-MMCs [53, 54].

The machining of MMCs as well as hybrid-MMCs is difficult for industries due to presence of two distinguished nature of materials as matrix in soft nature while hard and brittle nature of reinforcements. The hard and brittle nature of reinforcements make the MMCs as well as hybrid-MMCs much more difficult for shaping and leads to higher tool wears with poor surface finish with different existing machining processes [55, 56]. Due to this, machining of rotating parts made of MMCs becomes a major issue for industries due to rotating nature of workpieces like shaft, bars, tubes etc. Among various existing machining processes, turning process becomes a powerful method for shaping of rotating workpiece with application of the single point cutting tool. Mechanism of Chip formation in metal matrix composites look like, the behaviour of monolithic materials [57].

II. Turning of Metal Matrix Composites

Turning can be defined as a cutting process performed by single point cutting tool on the rotating surfaces (figure 1). It has wide industrial applications and broadly accepted by small as well as large scale industries. Conventional machining is considered for composites because their reinforcements are brittle and material separation is accomplished by brittle fracture rather than plastic deformation ahead of the tool. The turning of the MMCs becomes more difficult due to presence of the reinforced materials and leads to rapid tool wears due to the abrasive nature of the ceramics (reinforcements) particles. In some cases, the researchers are added the graphite particles into MMCs with reinforcements to enhance the machinability. With application of the graphite particles into the MMCs, the turning of the MMCs becomes easier and such products suitable for the inaccessible area where lubrication is much difficult due to the self-lubricating properties of the graphite particles.

The objective of the present work was to review the turning process as applied to metal matrix composites for different studies like tool life, tool wear mechanism, chip formation, surface quality and for optimization of machining parameters for improving cutting tool performance.

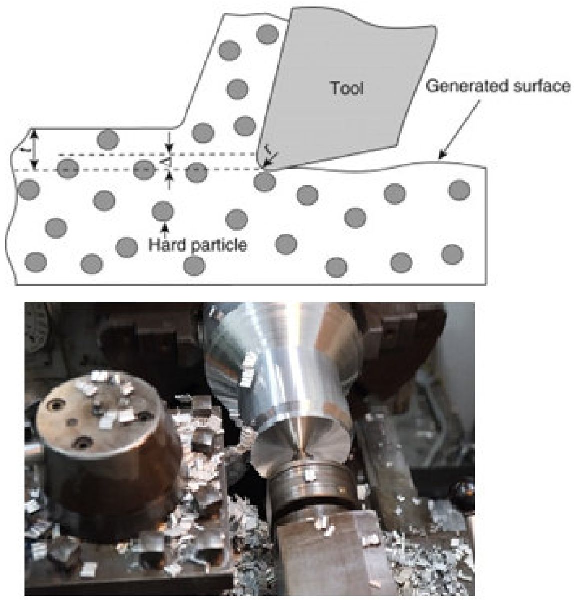

Figure 1. Machining of metal matrix composites

A. SELECTION OF CUTTING TOOLS

Tool selection is an important criterion in machining the metal matrix composites. As these cutting tools are very expensive so selection of cutting tool is plays a vital role along with the cutting parameters, carbide tools can be used for cutting operations. Reinforced particles are harder as compared to cemented carbide cutting tool so cutting tools harder than these particles needed to machine MMCs. Some carbide tools are available to machine MMCs with particles like Al2O3 and SiC even tool wear is much rapid during the cutting of reinforced material [58, 59]. For the machining of the MMCs, the poly crystalline diamond (PCD) cutting tool is mostly used by the researchers. The diamond cutting tool may be coated or brazed type. Even though, several researchers were claimed that the performances of uncoated PCD tool (figure 2) is much better that coated tool because the coated tool wear out rapidly after rapture of the coated materials [60]. Few researchers [61, 62], have used PCD tools wherein excellent chemical affinity of the MMC with the PCD has been noticed. Monaghan et al. [63] ranked various tool materials in the order of decreasing tool wear. As compared to the other cutting tool like polycrystalline cubic boron nitride (PCBN), the PCD tool life is higher with lower in tool wear phenomenon [64]. Hung [65] reported that PCD and PCBN tools (figure 3) to be much better than WC tools. Tomac et al. [66] Compared chemical vapor deposition inserts (CVD) to TiN, TiCN and Al2O3 coated tools. They confirmed superior performance of CVD tools over the others. Weinert and Biermann [67] promoted PCD and CVD inserts in machining MMCs due to their low tool wear rates. In machining MMCs regarding thermal, hardness and fracture properties PCBN tools also fare good against ceramic and cemented carbides. Improve fracture resistance of tools binders also helped [64]. Looney et al. [68] found that cubic boron nitride inserts shows the best machining performance in machining Al/SiC MMCs.

Figure 2. PCD turning tools.

Figure 3. PCBN turning tools.

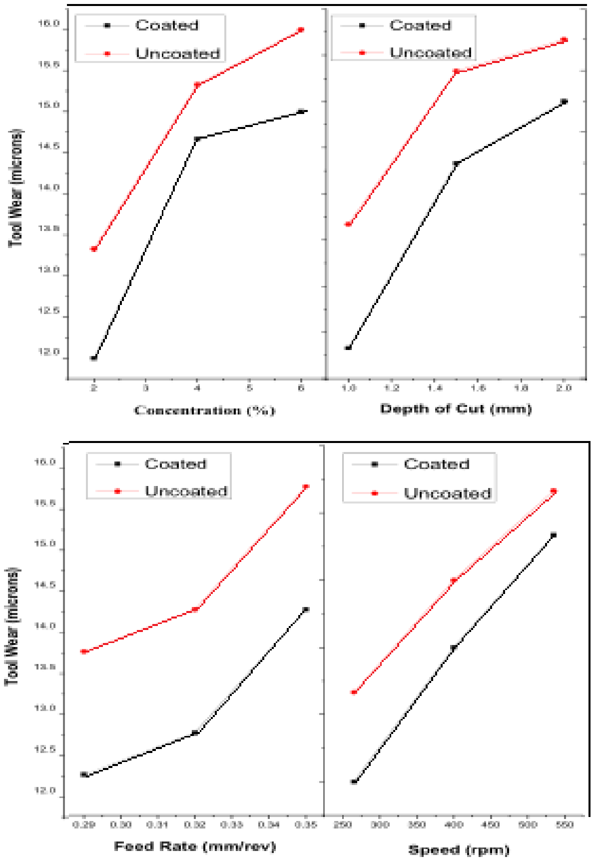

Figure 4. Tool wear on coated and uncoated carbide tool with respect turning parameters.

B. Tool wear

A case study of turning operation on AA2024/Al2O3 metal matrix composite using titanium nitride coated and uncoated carbide tool bit is shown in figure 4. Turing test was performed for 60 sec on conventional lathe machine. It has been observed that tool wear increases with increase in speed (rpm). This is because at higher speed tool- workpiece interface temperature increases, softening the tool material. This promotes the abrasive, adhesive and diffusional wear. The tool wear increases with increasing the feed rate. This is because at higher feed rates, greater is the cutting force per unit area of chip-tool contact on the rake face and the work tool contact on the flank face. This increases the cutting temperature and mechanical shock thereby increasing the tool wear. Similarly, tool wear increases with increasing the depth of cut. The area of contact increases with increase in depth of cut and accelerating the abrasive adhesive and diffusion type of tool wear. As the concentration of alumina is increased, the hardness of workpiece increases (figure 4). Also, alumina has been used as abrasive. This may result in more force per unit area of chip-tool contact thereby more tool wear. The case study revealed that abrasive wear is the main mode of tool failure. More recently Kishawy et al. [69] developed a model to predict flank wear rate considering two- and three-body abrasion between the MMC and tool, which were formulated using modified Archard's and Rabinowicz's relations, respectively (figure 5). The rate of volume loss of the cutting tool was calculated by incorporating the contributions of the two types of abrasions by taking the root-mean-square value. The rate of volume loss was correlated with length of flank wear land by considering the geometry of the cutting tool. A comparison between predictions and their experimental results showed reasonable agreement.

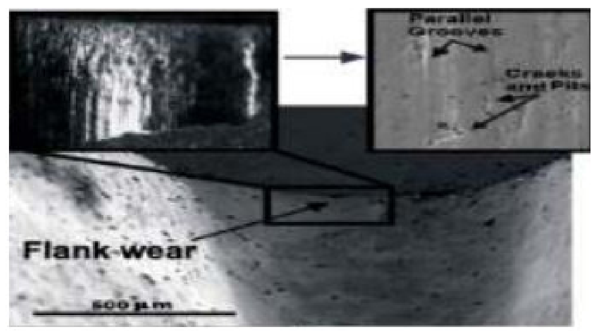

Figure 5. Flank wear [69].

C. Chip formation

Mechanism of Chip formation in metal matrix composites look like, the behavior of monolithic materials. Joshi and Dabade [70] highlighted that the most efficient and economical ways of studying the machining characteristics of any material is to study its chip formation details. It was stated that as the volume fraction of the reinforcement particles increases, the number of circles that the chips form before breaking decreases also explained the observation based on decreasing strain at failure of the chip curls. Hence, number of chip curls is directly related to material strain at failure. Ductility of the composite reduces as the increased volume fraction of the hard reinforcements reduces, supporting chip breakage. Tool rake angle affect the chips curl in case of the unreinforced aluminum alloy however composite chip curls remain unaffected. Fundamentally, chip curling depends on the ratio of plastic contact length to total contact length between the chip and the tool face [71]. With increase in this ratio flatness also increases. Therefore, as the rake angle decreases, chips turn out flatter (chips having greater diameter). At lower cutting speeds, shear strength of the alloy remains high, enabling chip breakage at smaller lengths. But the same does not happen in case of composites as their low ductility produces much smaller chips. However, it was observed that chip morphology of composites depends on the volume fraction of reinforcements.

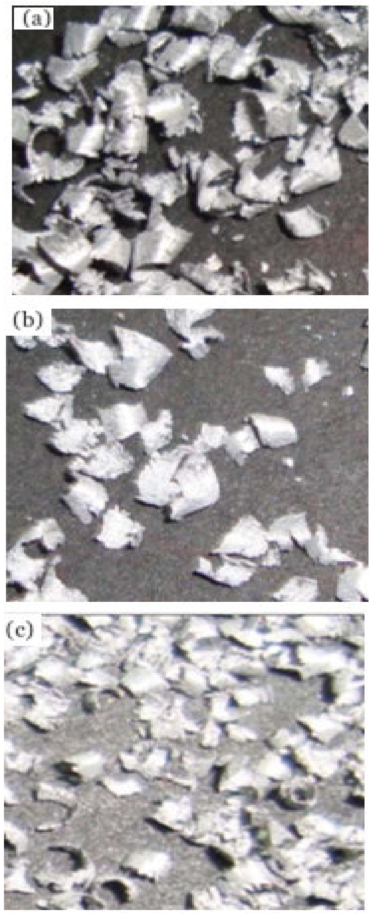

Figure 6. Size of Chips during machining of as cast LM6/ SiCp MMCs reinforced with (a)7.5 wt% SiCp, (b) 10 wt% SiCp and (c) 12.5 wt% SiCp.

The chips showed a tendency to stick to the tool face, restricting their movement for lower volume fractions, resulting in longer chips of larger diameters. Joshi and Dabade [70] have worked on a combined chip breaking criterion that is based on two conditions given by Nakayama [71] and Zhang [72]. Chip breaks when its strain reaches a certain limit, while the latter expressed this limit of strain on chip based on mechanical properties and chip breaker geometry. Comparison with obtained experimental results shows similarity with the model given by Nakayama [71]. Gallab and Sklad [73] also found continuous chips being formed at lower feed rates, which are difficult and hazardous in handling. Lin et al. [74] observed that cutting with sharp tool resulted in the formation of long, helical chips. As the tool became blunt, chips turned to short, helical shapes. It was explained by the researchers as due to lowered ductility of aluminum matrix due to chip breaking action by the built-up edges developed on the progressively blunt tool nose.

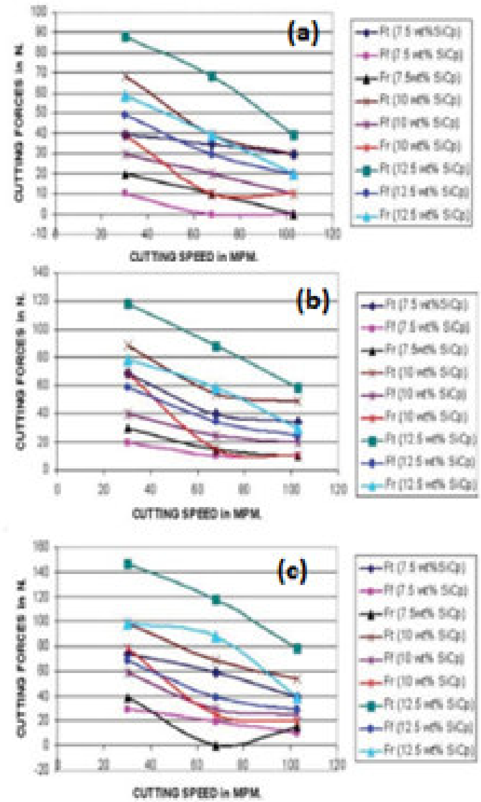

Figure 7. Effect of cutting speed on cutting forces (F_t), (F_f) and (F_r) during machining of LM6/SiCp MMCs reinforced with 7.5,10& 12.5wt%SiCp at constant feed rate 0.05mm/rev and at (a) Depth of cut =0.5mm; (b) Depth of cut =1.0mm and (c) Depth of cut =1.5mm.

The chips formed under dry conditions during turning operation of LM6/SiCp metal matrix composites are shown in figure 6 as a case study. The chip formation during machining has accompanied by very severe plastic deformation at the shear zone and owing to the lack of sufficient ductility of the work material. The addition of SiC particle reinforcement into the aluminium alloy matrix has caused a reduction in its ductility and produced a semi-continuous type of chip during machining of these MMCs without chip breaker. This could be beneficial to the machinability point of view. It not only improves the machinability of this composite. The size of chips has also affected by the percentage of reinforcement particles in cast MMCs. It is observed that the sizes of chips are decreases on increasing the weight percentage of

SiCp in cast MMCs. Figure 7 (a), (b) and (c) shows, the photographs of chips produced during machining of as cast LM6/SiCp metal matrix composites.

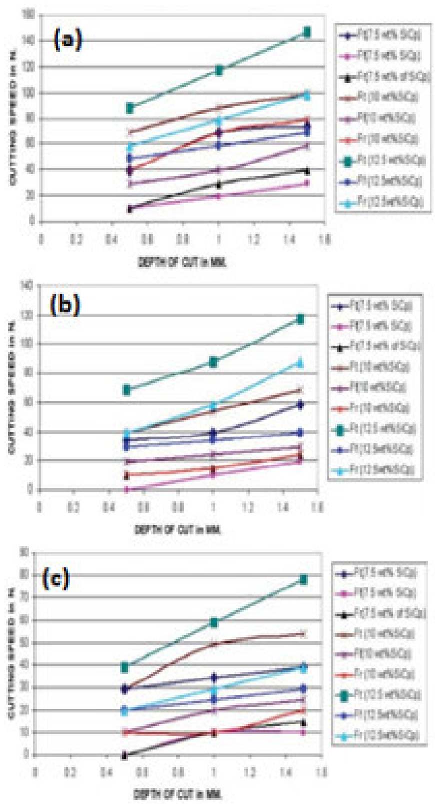

Figure 8. Effect of depth of cut on cutting forces (F_t), (F_f) and (F_r) during machining of LM6/SiCp MMCs reinforced with 7.5,10& 12.5wt% SiCp at constant feed rate 0.05 mm/rev and at (a) Cutting speed =30mpm; (b) Cutting speed =68mpm and (c) Cutting speed =103mpm.

Figure 8 shows the effect of depth of cut on the cutting force (Ft), feed force (Ff) and radial force (Fr) at constant 0.05 mm/rev feed and different cutting speed. The experimental results represent that for all the cast composites the cutting force components Ft, Ff and Fr were increases on increasing the depth of cut. The cutting force components i.e. Ft, Ff and Fr are higher at depth of cut 1.5mm comparison to 0.5 and 1.0mm depth of cut for the same conditions i.e. constant cutting speed and constant feed rate. It also shows that the cutting force components are increases on increasing the weight fraction of SiCp in the cast MMCs at the same cutting conditions. The cutting force components i.e. Ft, Ff and Fr are higher for the composite having 12.5wt% of SiCp comparison to composite having 7.5wt% and 10 wt% of SiCp at a constant cutting condition. The results show that on increasing the weight percentage of SiCp in cast MMCs the required cutting forces are increased during machining of cast MMCs at dry condition. Manna et al. [76] reported that during dry turning of Al/SiCp/15p with the help of uncoated tungsten carbide (WC) cutting tool, the cutting forces (i.e. feed force, Px and cutting force, Pz) are increases on increasing the feed rate and depth of cut at constant cutting speed. They also reported that on increasing the cutting speed, the cutting forces are decreases at constant feed (i.e. 0.5mm/rev.) and depth of cut (0.5 mm). The relation between cutting forces and cutting speed is almost same as observed in the present case study.

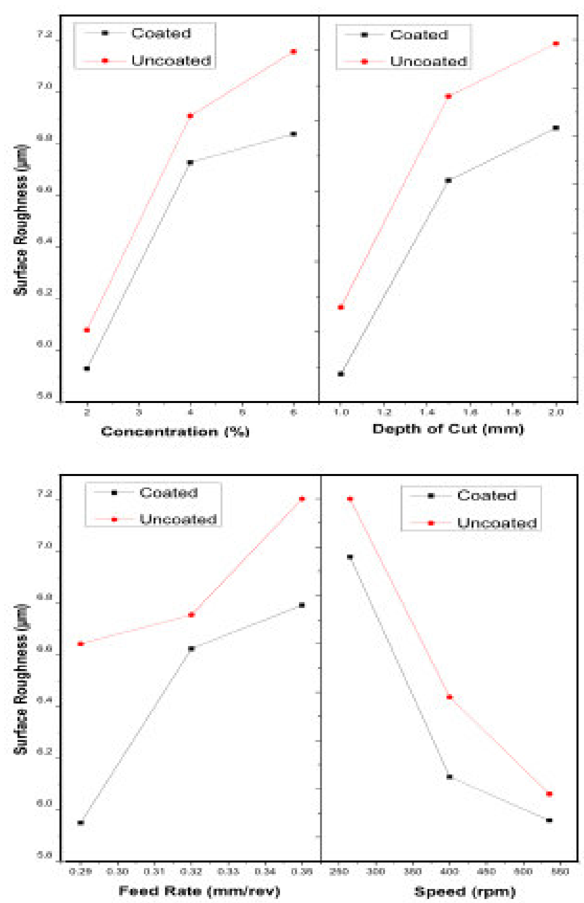

Figure 9. Surface Roughness on coated and uncoated tool with respect to process parameters.

D. SURFACE ROUGHNESS

Surface roughness was studied on Al2024/Al2O3 to know the surface irregularities during machining since alumina is abrasive in nature. As it is very difficult to machine the surface roughness revels the behaviour of manufactured composite materials after machining. The cut of length is 0.8 mm and least count of Ra value is 1 micron. Figure 9 shows the variations of surface roughness for all the process parameters i.e concentrations of reinforced ceramic particle, speed, feed rate and depth of cut. It has been observed that surface roughness decreases with increase in speed. This is due to fact that at higher cutting speeds, cutting forces and tendency towards built-up edge formation weakens due to increase in temperature and consequent decrease of frictional stress at the rake. The surface roughness increases with increase in the feed rate. This is because the height of the peaks and the depth of the valleys of feed marks are proportional to the square of the feed per revolution. Also, the higher values of feed increase the tool wear rate. The surface roughness has been found to be increased with increasing the depth of cut. This is because, as the depth of cut is increased, cutting forces increases. Hence, the waviness of peaks increases leading to increase in surface roughness. As increasing the concentration ratio of alumina particle in aluminum, the surface roughness has been found to be increased due to abrasive behaviour of alumina.

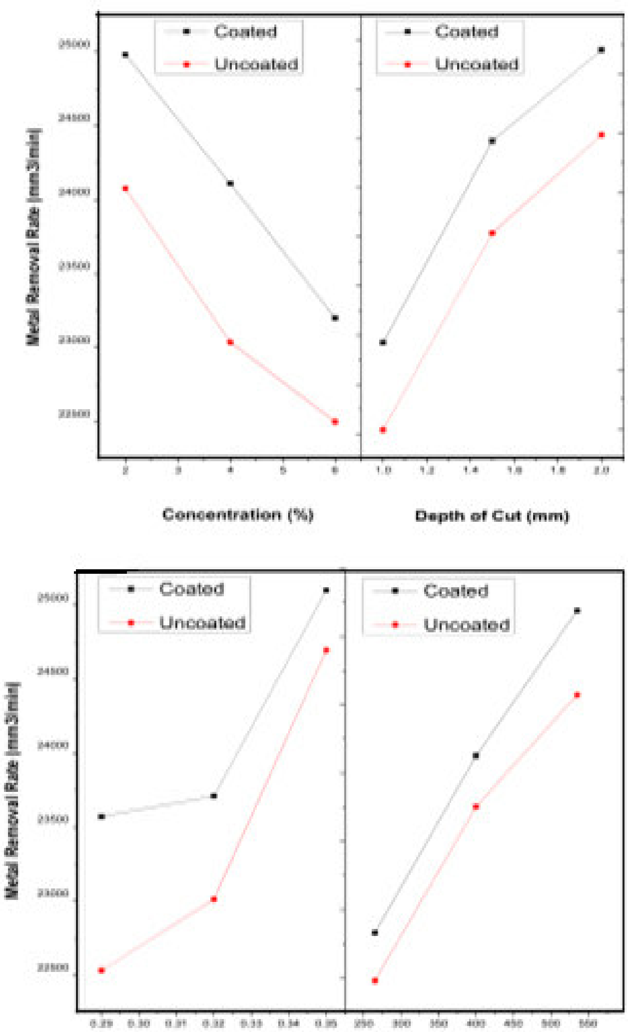

Figure 10. MRR on coated and uncoated tool with respect to process parameters.

E. Material removal rate

Metal removal rate is determined by the rate of change in volume. From main effect plot of MRR (figure 10), it has been observed that material removal rate (MRR) increases with increasing the speed. This is because time is an important factor for MRR, for the same time at maximum speed number of turns increased. MRR increases with increasing the feed rate, but initially at lower feed rate MRR has been found to be increasing slowly. Similar pattern has been observed in case of depth of cut. Increasing the depth of cut the MRR also increased because the maximum thickness of chip may be removed. But as the concentration ratio of alumina is increased, the MRR is found to decrease. This is due to abrasive nature of alumina particles. The TWR has also been increased with increasing alumina concentration.

III. Research in Turning of Metal Matrix Composites

The turning of MMCs is an emerging field of the research. The research works published on the turning of the MMCs are summarized in the Table 1.

The machining of MMCs as well as hybrid-MMCs is difficult for industries due to presence of the two distinguished nature of materials as matrix in soft nature while hard and brittle nature of reinforcements. The hard and brittle nature of reinforcements make the MMCs as well as hybrid-MMCs much more difficult for shaping and leads to higher tool wears with poor surface finish with different existing machining processes. Due to this, machining of rotating parts made of MMCs becomes a major issue for industries due to rotating nature of workpieces like shaft, bars, tubes etc. Among various existing machining processes, turning process becomes a powerful method for shaping of rotating workpiece with application of the single point cutting tool.

Turning can be defined as a cutting process performed by single point cutting tool on the rotating surfaces. It has wide industrial applications and broadly accepted by small as well as large scale industries It is used for turning of the almost all the known materials after selecting an appropriate cutting tool for the particular materials.

TABLE 1. SUMMARY OF PUBLISHED WORKS ON TURNING OF MMCS

S.No.	Name of Authors	Year	MMC	Cutting Tool	Critical Finding
1	J. T. Lin , D. Bhattacharyya and C. Lane [74]	1995	Al359/SiC (20%vol.)	PCD	Surface finish is unaffected by cutting speed and slightly wear tool gives better finish.
2	A. R. Chambers [62]	1996	Al356/SiC (15% vol.)	PCD and Cemented Carbide	Performance of PCD tool was better than cemented carbides due to superior in abrasion and wear resistance.
3	S. Durante, G. Rutelli, and F. Rabezzan [77]	1997	Al/SiC (20% vol.)	PCD, PCD Coated and WC	Diamond coating gives longer tool life but rapidly wear in dry/wet cutting conditions and PCD tool life is better than coated tools.
4	L. Iuliano, L. Settineri and A. Gatto [78]	1998	Al/Al_2O_3	PCD Coated and Uncoated	Localized forces and thermal stress cause the coating to be removed along a line parallel to the cutting edge.
5	M. E. Gallab and M. Sklad [79]	1998	Al/SiC (20% vol.)	PCD, Alumina and Coated Carbide	Alumina and coated carbide tools suffer with high edge and crater wear during turning than PCD tool.
6	M. E. Gallab and M. Sklad [80]	1998	Al/SiC (20% vol.)	PCD	Surface finish improves with increases in the feed rate and cutting speed but it declines with increase in depth of cut.
7	V. Songmene and M. Balazinski [81]	1999	Al/SiC, Al/Al_2O_3 with Gr	TiCN coated carbide	Graphite reinforced MMCs are easier to machine than those MMCs reinforced with SiC or SiC particles only.
8	N. P. Hung, T. Tan, Z. W. Zhong and G. W. Yeow [82]	1999	Al/SiC and Al/Al_2O_3	PCD and SCD	Both tools i.e. PCD and single crystalline diamond (SCD) produces almost similar surface quality.
9	Z. Zhong and N. P. Hung [83]	2000	Al/SiC and Al/Al_2O_3	PCD and SCD	At lower depth of cut both tools (PCD and SCD) show almost same behaviors.
10	C. J. E. Andrewes, H. Y. Feng and W. M. Lau [84]	2000	Al/SiC	PCD and CVD diamond	Higher flank wear occurs with CVD diamond tool than PCD cutting tool.
11	M. V. Ramesh W. B. Lee, C. F. Cheung and K.C. Chan [85]	2001	Al6061/SiC (15%vol.)	PCD	The SiC particles led to large fluctuation in the cutting and thrust forces as which higher vibration occurs.
12	G. E. D. Errico and Calzavarini [86]	2002	A356/SiC Al/Al_2O_3	PCD and CVD diamond	Thick coating of CVD cutting tool performs near to DVD tool.
13	Y. Sahin, M. Kok and H. Celik [87]	2002	Al2024/Al_2O_3 (30%wt.)	TiN Coated Carbide	Tool life increases with increase in cutting speed but surface finish decreases with increase in reinforcement

14	J. P. Davim [60]	2002	A356/SiC (20%vol.)	PCD and CVD Diamond Coated	CVD diamond coated tools show short life as compared to the PCD tool.
15	Y. S. Varadarajan, L. Vijayaraghavan. and R. Krishnamurthy [88]	2002	Al/AlSi (25% vol.)	PCBN	PCBN better tool material that is highly efficient for turning MMCs in terms of wear and surface quality.
16	A. Mannaa and B. Bhattacharayya [89]	2003	Al/SiC (15%vol.)	Uncoated WC	Flank wear rate is high at low cutting speed due to the high cutting generation.
17	I. Ciftci, M. Turker and U. Seker. [58]	2004	Al/SiC (6% and 16%vol.)	Coated and Uncoated Carbide	Coated carbide tool performs better than uncoated but uncoated tool produces gives surface finish.
18	Y. Sahin and G. Sur [90]	2004	Al/SiC (10%vol.)	Alumina, TiN and Ti coated	TiN coated tool wears lower than that of Al_2O_3 –coated cutting tool.
19	I. Ciftci, M. Turker and U. Seker. [91]	2004	Al/SiC	PCBN	PCBN tool not unsuitable due to heavy fracture in cutting edge and nose radius.
20	X. Ding, W. Y. H. Liew and X. D. Liu [64]	2005	Al/SiC	PCBN and PCD	PCD tool perform better than PCBN due to higher abrasion and fracture resistance.
21	Y. Sahin [92]	2005	Al/SiC (10% and 20%wt)	Coated Carbide	Wear performance of multi-layer coated tools was found than those of double-coated tools during machining of the particle composites.
22	S. Kannan and H. A. Kishawy [93]	2006	Al/Al_2O_3	WC	Lower volume fraction and coarser the Particles leads to higher micro-hardness.
23	J. P. Davim, J. Silva and A. M. Baptista [94]	2007	Al/SiC (20%vol.)	PCD	Shear and normal stresses decrease with the increase in the feed rate.
24	N. Muthukrishnan, M. Murugan and P. Rao [95]	2008	Al356/SiC (10%vol.)	PCD	BUE forms at low cutting while higher speed gives better surface quality.
25	S. Basavarajappa [96]	2009	Al/SiCp/Gr	Carbide, Coated Carbide and PCD	Graphite reduces tool wear and PCD tool performs better than Carbide and Coated Carbide tools.
26	U. A. Dabade and S. S. Joshi [97]	2009	Al/SiC	PCD	Coarser reinforcements into MMCs lead to fracture and higher shear plane angle.
27	M. Seeman, G.Ganesan, R. Karthikeyan and A. Velayudham [98]	2010	Al/SiC (25%vol.)	Uncoated Carbide	BUE significantly affects the tool wear and surface roughness at low speeds whereas thermal softening plays important role at higher speeds and feed rates.
28	V. Anandakrishnan and A. Mahamani [99]	2011	Al/TiB_2	Uncoated WC	Flank wear, cutting force, and roughness increases with increases with depth of cut

					while feed rate leads in high flank wear, cutting force and surface roughness.
29	A. Schubert and A. Nestler [100]	2011	AA2124/25% SiC	CVD diamond Tipped indexable inserts	An increasing flank wear land width of the inserts led to a reduction of the surface imperfections.
30	N. Muthukrishnan, T. S. M. Babu and R. Ramanujam [101]	2012	Al/SiC/B_4C	PCD	Higher cutting speeds gives better surface finish but leads in faster tool wear.
32	S.P. Dwivedi, S. Kumar and A. Kumar [102]	2012	A356/SiC (5%vol.)	WC	Surface roughness decreases with increase in speed while increases with increase in the depth of cut and feed rate.
33	S. Basavarajappa and J. P. Davim [103]	2013	Al /SiCp and Al/SiCp/Gr	Coated Carbide and PCD	Graphite MMCs produce lead to easy turning. PCD tool performs better than carbide/coated carbide tools.
34	P. Bansal and L. Upadhyay [104]	2013	Al/Al_2O_3	TiN Coated/ Uncoated Carbide	Coated cutting tool perform better that uncoated in term of higher tool life.
35	A.Kumar, M. M. Mahapatra and P. K. Jha [105]	2014	Al/Cu/TiC	Uncoated ceramic	BUE forms in low amount at higher speed and higher at lower speed. The length of chip increases with an increase in cutting speed.
36	P. Suresh, K. Marimuthu, S. Ranganathan band T. Rajmohan [106]	2014	Al/SiC/Gr	PCD	Graphite particles into MMCs enhance the machinability of MMCs.
37	S. K. Tamang and Chandrasekaran [107]	2015	Al/SiC	PCD	Surface roughness and tool wear increases with increase in feed rate and depth of cut. Soft computing technique shows better responses for modeling and optimization.
38	R. Kumar and S. Chauhan [108]	2015	Al/SiC and Al/SiC/Gr	PCD	The machinability of Al/SiC/Gr composites is much better than Al/SiC composites.
39	J. N. Muguthu, G.Dong and B.W. Ikua [109]	2013	Al2124SiCp (45%wt)	PCBN and PCD	Uncoated PcBN had greatest wear followed by coated PcBN and finally PCD tool. On tool wear the results showed that PcBN tools suffered severe wear as compared to PCD tools.
40	A. Gatto, L. Iuliano, E. Atzeni, P. Minetola and A. Salmi [110]	2016	Al/SiC	PCD	The mechanisms involved in cutting are similar for whiskers and particulates reinforcements.
41	V. Hiremath, P. Badiger, V. Auradi, S. T. Dundur and S. A. Kori [111]	2016	Al/B_4Cp	PCD	Cutting speed affects the roughness while depth of cut shows negative influences on surface roughness. The cutting

					forces decreases with increase in speed.
42	P. Bansala and L. Upadhyay [112]	2016	Al/Al_2O_3	Uncoated Carbide	Hardness and tensile strength increase with reinforcement ratio. The speed made adverse effect on surface roughness.
43	K. Erdogan and G. Ali [113]	2016	$Al6061/Al_2O_3$	Cemented Carbide	The main cutting force values linearly decreased as the cutting speeds increased. Although the feed rates and cutting forces did not linearly correlate, increasing the feed rate slightly increased the cutting forces.

IV. CONCLUSION

Metal matrix composites have entered in industry with extreme interest from the automobile and aerospace sectors due to their superior mechanical properties and applications. Many researchers have been worked for the machining of metal matrix composites. In this paper a brief overview is provided related research, focusing on turning mechanisms. The PCD cutting tool has been found better for turning of MMCs than PCBN, SCD and carbide based cutting tool materials. The coated cutting tool performs better as compared to the uncoated cutting tools but leads in high wears after rupture of coating. The performances of multi-layer coated tool were found near to PCD turning tool. Surface Roughness increase with the process variables except the speed, speed made adverse effect on surface roughness. MRR increases with the process parameters except the concentration of reinforced particles due the presence of hard ceramic particles. Even though, for the conventional alloys the deformation behavior and the friction law governing chip–tool interface friction during machining has not yet been well defined. In addition, the effect of reinforcement particles on the deformation mechanisms during machining of MMCs is also not fully understood. There is still research required to clarify these interactions before we can go deep into the new possible concepts and further developments regarding MMCs and machining.

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