International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Effect of Process Parameters on Surface Roughness in Face Milling of AA1100/10wt%ZrO_2 MMC

Kapil Singh[1], Dr. Rajesh Kr. Bhushan[2]

[1]Assistant Professor, Arni University, Kathgarh, H.P India

[2]Associate. Professor Institute of Technology, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur, Chhattisgarh India

Abstract: ***In present work, an attempt has been made to experimental investigate the machinability of aluminum metal matrix composite during continuous face milling of composite bars using carbide inserts. The aluminum metal matrix composite was fabricated by stir casting process. Base matrix material is Aluminum Alloy 1100 reinforced with 10wt% Zirconium oxide particles of mean diameter 20 µm to 40 µm is used. Experiments has been performed on CNC Vertical Milling center by using carbide insert at various cutting conditions and parameters such as cutting speed, feed and depth of cut and surface roughness was found at different levels. The effect of machining parameters, e.g. cutting speed and depth of cut on the surface roughness has been discussed.***

Keywords: Aluminum metal matrix composite, Surface roughness (SR), CNC Vertical Milling Center.

1. Introduction

Aluminum metal matrix composites refer to the class of light weight aluminum centric systems which are characterized by superior physical and mechanical properties. An advantage of using these materials than the non-reinforced aluminum alloys can be attributed to the fact that properties of aluminum metal matrix composites can be tailored to the demands of different industrial applications by suitable combinations of aluminum matrix, reinforcement and processing route. Although, the presence of ceramic reinforcements in these materials likes SiC, Al_2O_3, etc improve stiffness, hardness; wear resistance, etc as desired in typical industrial applications, but also makes machining like face milling difficult.

2. Material preparation

The matrix material used in this study is AA1100 (Figure 1). Table 1 shows the chemical composition of AA1100. The reinforcement material added was ZrO_2 (Figure 2). The addition of ZrO_2 particles improves high fracture toughness, wear resistance, hardness, strength, and stiffness. The composite was prepared using stir casting process. AA1100 is kept in graphite crucible inside the muffle furnace. The alloy was melted to the desired heating temperature of 645°C. The preheated reinforcement particles with an amount of 10 wt% of ZrO_2 particles and size of 20 µm to 40 µm were introduced into the vortex of the molten alloy after effective heating.

Figure 1: Aluminum Alloy 1100

Figure 2: Zirconium Oxide Powder

Mechanical stirring of the molten alloy for duration of 20mins was achieved by using a stirrer. The speed of the stirrer was maintained at 350rpm. The melt was poured at 635°C into a mild steel mould. Then the mould was left in air to cool down to room temperature and then the cast composite was obtained.

Table 1: Chemical composition of AA 1100

Alloy	Si+ Fe	Cu	Mn	Be	Zn	Al
1100	0.80 Si+Fe	0.05	0.09	0.00070	0.05	Remainder

3. Experimental Work

The main objective of this experimental work was to study the effect of cutting speed, feed, and depth of cut for AA1100/ZrO_2 composite in CNC vertical milling centre (Figure 3) for surface roughness and investigate the surface roughness after machining. To study the effect on surface roughness, various parameters and levels selected are listed in Table 2.

Figure 3: Vertical Milling Centre

Table 4.3: Technical Specifications of VMC

S.No.	Parameter	Unit	Range
1	Spindle Power	(Kw)	5.5 - 7.5
2	Spindle Speed	(RPM)	60-6,000
3	Traverse (X)	(mm)	510
4	Traverses (Y)	(mm)	510
5	Traverses (Z)	(mm)	510
6	Work Table Size	(mm)	700 x 520
7	Tools Magzine	No of Tools	16

Figure 1: Cast AA1100/10wt%ZrO2

Table 2: Parameters and level selection

Spindle Speed(rpm)	500	1000	2000	3000	4000
Feed (mm/min)	10	20	40	60	80
D.O.C (mm)	0.1	0.25	0.5	0.75	1

4. Results and Discussions

Work piece material Aluminum Alloy 1100 reinforced with 10wt% Zirconium oxide particles composition is already shown above. It has got low thermal expansion and good wear resistance. It is observed that while machining AA1100/10wt%ZrO2 work piece, discontinuous chips are formed. Experimental data related to surface roughness characteristics three graphs are plotted using MS-Word 2007 software application

Table 3: Varying the Speed (Feed and DOC constant)

S.NO.	Spindle Speed (rpm)	Feed (mm/min)	DOC (mm)	SR(R_a) µm
1	500	40	0.5	4.735
2	1000	40	0.5	2.342
3	2000	40	0.5	1.786
4	3000	40	0.5	1.376
5	4000	40	0.5	1.152

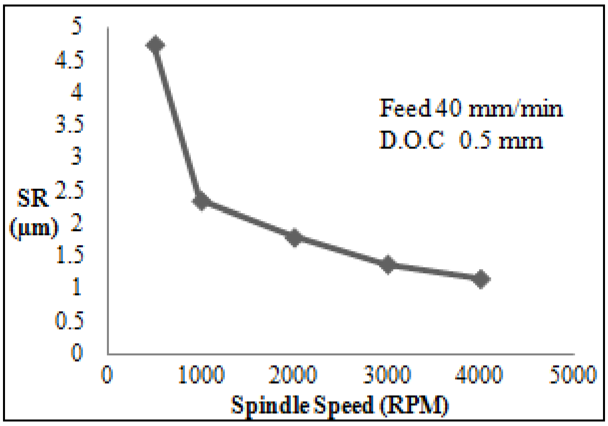

Figure 2: Change of surface roughness with spindle speed

Table 3 shows the change of surface roughness with spindle speed when the feed and depth of cut are kept at the mid value i.e; 40 mm/min and 0.5 mm respectively. It is seen from the graph of Surface roughness Vs. Spindle Speed that when feed & depth of cut are kept constant and only Spindle speed is increased continuously we can see from the graph that when the value of spindle speed is 500 rpm the value of surface roughness is very high (4.735 µm) but when the spindle speed is increased from 1000 to 4000 rpm the value of SR decreases sharply. The minimum value of surface roughness (1.152 µm) can be achieved when the Spindle speed is at 4000 rpm.

Table 4: Varying the Feed (Spindle Speed and DOC constant)

S.NO.	SPINDLE SPEED(rpm)	FEED (mm/min)	DOC (mm)	SR(R_a) µm
1	2000	10	0.5	2.891
2	2000	20	0.5	1.564
3	2000	40	0.5	1.775
4	2000	60	0.5	1.877
5	2000	80	0.5	2.148

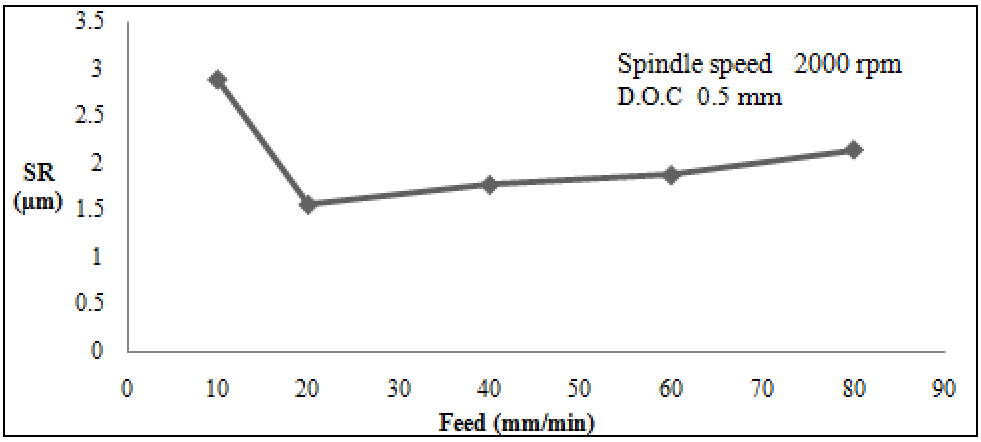

Figure 3: Change of surface roughness with feed gradually

Table 4 shows the change of surface roughness with the feed rate when the spindle speed and depth of cut are kept at mid value i.e. 2000 rpm and 0.5 mm respectively. Figure 3 shows the change of Surface roughness with the increase in feed. It is seen from the graph of Surface roughness Vs. feed that when Spindle speed and depth of cut are kept constant and only feed is increased surface roughness increases gradually.

Table 5: Varying the D.O.C (Spindle Speed and Feed constant)

S.NO.	Spindle Speed (rpm)	Feed (mm/min)	DOC (mm)	SR(R_a) μm
1	2000	40	0.1	1.471
2	2000	40	0.25	1.475
3	2000	40	0.5	1.733
4	2000	40	0.75	1.734
5	2000	40	1	2.211

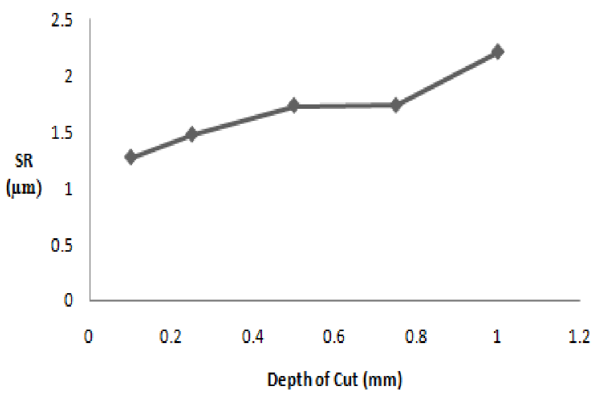

Figure 4: Change of surface roughness with depth of cut

Table 5 shows the variation of surface roughness with depth of cut when the spindle speed and feed are maintained at mid value i.e. 2000 rpm and 40 mm respectively. Figure 4 the curve between surface roughness and depth of cut. The surface increases with increase in depth of cut. The increase in surface roughness is minimum from 0.2 mm to 0.8 mm depth of cut.

5. Conclusion

In this work, effects of ZrO2 reinforcement to 1100 Al alloy on surface roughness during Milling have been investigated in terms of selected parameters such as Spindle speeds, feed rates, and depth of cuts. For optimum surface roughness in the work piece, it is recommended that Milling operation on Al alloy composite by carbide insert should be carried out at, spindle speed within the range of 1000 to 4000 rpm, feed rate within range of 40 to 80 mm/min, and DOC within range of 0.1. Among all the cutting parameters affecting surface roughness of the Al alloy composite (AA1100/10wt%ZrO2), surface roughness shows decreasing trend sharply as the Spindle speed increases, feed rate shows gradual effect on surface roughness, when we increase the feed rate and depth of cut has showing minimum effect on surface roughness while we increase the depth of cut from 0.2 mm to 0.8 mm. Spindle speed and feed rate has maximum effect on surface roughness

References

[1] Lilholt, H. and Lawther, J.M. “Comprehensive Composite Materials”, Chapter 1.10, 2000, Elsevier Ltd.
[2] Malli, N, Aaditya, V. and Raghavan, R. (2012) “Study and analysis of PCD 1500 and 1600 Grade inserts on turning Al6061alloy with 15% reinforcement of SiC particles on MMC” , IPCSIT vol.31 IACSIT Press, Singapore.
[3] Arokiadass, R. Palaniradja, K. Alagumoorthi, N. (2012) “Prediction and optimization of end milling process parameters of cast aluminum based MMC”, Science Direct, Trans. Nonferrous Met. Soc. China 22(2012) 1568−1574.
[4] Bhushan, R. K., Kumar, S. and Das, S. (2010) “Effect of machining parameters on surface roughness and tool wear for 7075 Al alloy SiC composite”, International Journal of Advanced Manufacturing Technology, 50:459–469.
[5] Singh, S., Singh, K. and Bhushan, R.K. (2012) “Machining Response in Turning Aluminum composite LM13 With 15% SiC”, International Journal of enhanced Research in Science Technology & Engineering, VOL. 1 Issue 1.
[6] Muthukrishnan, N. and Davim, J. (2009) “Optimization of machining parameters of Al/SiC-MMC with ANOVA and ANN analysis”, Journal of Materials Processing Technology, 225–232.
[7] Li, Z. Huang, S. T. Wang, D. and Yu, X. L. (2011) “Finite element and experimental studies of the cutting process of SiCp/Al composites with PCD tools”, International Journal of Advanced Manufacturing Technology, 52:619–626.

[8] Pramanik, A. Zhang, L.C. and Arsecularatne, J.A. (2006) "Prediction of cutting forces in machining of metal matrix composites", International Journal of Machine Tools and Manufacture, 46, 1795–1803.

[9] Oktem, H. Erzurumlu, T. and Col, M. (2006) "A study of the Taguchi optimization method for surface roughness in finish milling of mold surfaces", International Journal of Advanced Manufacturing Technology, 28: 694–700.

[10] John, D. Christos, K. Menelaos, K. and Ioannis, E (2011) "Parameter Optimization during Finish End Milling of Al Alloy 5083 using Robust Design" Proceedings of the World Congress on Engineering, Vol I.

[11] Chandrasekaran, M. and Devarasiddappa, D. (2012) "*Development of Predictive Model for Surface Roughness in end Milling of Al-SiCp Metal Matrix Composites using Fuzzy Logic*" World Academy of Science, Engineering and Technology.

[12] Arokiadass, R. Palaniradja, K. and Alagumoorthi, N. (2012) "*Study of Tool Wear & surface Roughness in end milling of particulate Aluminum MMC with RSM*" Journal of Computational and Applied Research In Mechanical Engineering, Vol 2, No. 1, pp. 1-12.

[13] Arokiadass, R. Palaniradja, K. and Alagumoorthi, N. (2011) "*Surface roughness prediction model in end milling of Al/SiCp MMC by carbide tools*", International Journal of Engineering, Science and Technology ,Vol. 3, No. 6, pp. 78-87.

[14] Babu, G. Selladurai, B. and Shanmugam, R. (2008) "*Analytical modeling of cutting forces of end milling operation on Al-SiCp using RSM"* ARPN Journal of Engineering and Applied Sciences, Vol. 3, No. 2.

[15] Arokiadass, R. Palaniradja, K. and Alagumoorthi, N. (2011) " *Effect of process parameters on surface roughness in end milling of Al/SiCp MMC*" International Journal of Engineering Science and Technology (IJEST), Vol. 3 No. 1.

[16] Arokiadass, R. Palaniradja, K. and Alagumoorthi, N. (2011) " *Predictive modeling of surface roughness in end milling of Al/SiCp MMC*" Archives of Applied Science Research, 3 (2):228-236.

[17] Joshi, A. Kothiyal, P. (2012) "Investigating *Effect of Machining Parameters of CNC Milling on Surface Finish by Taguchi Method*" International Journal on Theoretical and Applied Research in Mechanical Engineering (IJTARME), Volume-1, ISSN: 2319 – 3182.

[18] Choubey, A. (2012) "*The Implementation of Taguchi Methodology for Optimization of end milling process parameter of mild steel"* International Journal of Engineering Science and Technology (IJEST), Vol. 4 No.07, ISSN: 0975-5462.

[19] Soleymani yazdi, M, R. Khorram, A. (2012) *"Modeling and Optimization of Milling Process by using RSM and ANN Methods"* International Journal of Engineering and Technology, Vol.2, No.5, ISSN: 1793-8236.

[20] Selvam, M. Dawood, A.K. and Karuppusami, G. (2012*)* *" Optimization of Machining Parameters for face milling operation in a vertical CNC milling machine using genetic algorithm" IRACST* – Engineering Science and Technology: AnInternational Journal (ESTIJ), Vol.2, No. 4, ISSN: 2250-3498.

[21] Kakati, A, K. Chandrasekaran, M. Mandal, A. and Singh, A, K. (2011) *"Prediction of Optimum Cutting Parameters to obtain Desired Surface in Finish Pass end Milling of Aluminium Alloy with Carbide Tool using Artificial Neural Network"* World Academy of Science, Engineering and Technology 57 2011.

[22] D.C. Montgomery(2001), "Design and Analysis of Experiments", 5nd Edition. John Wiley, New York.