PAPER • OPEN ACCESS

Investigation of aluminium composites by milling

To cite this article: J. Líska and Zs. Kovács 2018 IOP Conf. Ser.: Mater. Sci. Eng. 448 012070

View the article online for updates and enhancements.

You may also like

- <u>Correlation of cerebrovascular disorder</u> and anxiety: <u>The Kecskemet study</u> Kornel Sipos, Michael Bodo, Piroska Szalay et al.
- <u>Spatial-temporal analysis of urban climate</u> <u>dynamics in major Hungarian cities</u>
 Attila Buzási, Bettina Szimonetta Beszedics-Jäger and Olivér Hortay
- MODULATION OF THE GALACTIC LOW-ENERGY PROTON SPECTRUM IN THE INNER HELIOSPHERE K. Kecskeméty, Yu. I. Logachev, M. A. Zeldovich et al.





DISCOVER how sustainability intersects with electrochemistry & solid state science research



This content was downloaded from IP address 3.141.29.145 on 09/05/2024 at 08:32

Investigation of aluminium composites by milling

J. Líska¹ and Zs. Kovács²

¹Associate professor, John Von Neumann University, Kecskemét, Hungary ²Assistant, John Von Neumann University, Kecskemét, Hungary

E-mail: liska.janos@gamf.uni-neumann.hu

Abstract. The article deal with the attendants of milling aluminium composites. We can use aluminium composite with ceramic matrix. This type of material used in the industry at the produce of foam matierials. During cutting of basic material is not easy, because the high tool wear and some attendants harden the machining.

1. Introduction

Most materials are machined by cutting in the knowledge of the right technology. These knowledge applies not only to the cutting process but also to the correct tool selection and the application of the optimum technological parameters. This summary examines the cutting possibilities of aluminum composites which are similar to ALUFOAM (see in Fig. 1.). The aim of the authoress to get a comprehensive picture about the possibilities of machinability of aluminum composites in the world.





Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI. Published under licence by IOP Publishing Ltd

XXIII International Conference on Manufacturing (Manufacturing 2018)	IOP Publishing
IOP Conf. Series: Materials Science and Engineering 448 (2018) 012070	doi:10.1088/1757-899X/448/1/012070

After studying foreign and domestic publications, it can be stated that not only the machinability of the composites were investigated, but also the machined surface' quality and the changings in the cutting zone. All this leads to the conclusion that the processing of aluminum composites requires a complex and comprehensive knowledge.

Among the cutting machining, milling is one of the most complex machining technology because there is a wide range of tool and machine selection.

Sener Karabulut at al. also investigated the surface roughness and cutting strength for aluminum alloy (AA7039/Al2O3). They also made several experiments which were evaluate by Taguchi's method. As a result, it has been found that the tooth per feed has the greatest effect on the cutting force (Figure 2), while the material composition has great influence on roughness (Figure 3) [2].



Fig. 3 Effect of cutting parameters on average S/N ratio for Ra [2]

2. Design of Experiment

During the experiments, two types of material were used - M6061 and C347 (hereinafter Material 1, Material 2). The Material 1 is a 6061 aluminum alloy and the Material 2 is a composite of the Material 1 (Fig. 4). This means that during the pre-fabrication processes of Al 6061 alloy was reinforced with 6 micron grain size Al_2O_3 at a density of 6%. The workpieces were 150x30x4 dimension (Fig. 5a). The free cutting technology was ensured, where the tip of the tool did not engage during cutting.



Fig. 4 The used workpieces M6061 (a) and C347 (b)



Fig. 5 Dimension of workpieces (a) and machining strategy (b)

The applied tool was a milling cutter, type of SANDVIK COROMANT N331.1A-05 45 08H-NL 1130 with AlTiCrN PVD coated (Fig. 6). The diameter of the milling tool was Ø100 mm and at the same time, only one carbide inserts was attached in the tool. It was necessary, to can be safely record the chipping process. During the milling process straightforward technology were applied, in case the carbide insert start with the maximum chip cross parameter while at exit time is approximately 0.



Fig. 6 Fixed cutting insert into the tool holder

During the experiments, a total of 8 adjustments $(2^3 = 8)$ were made based on the full factorial experiment, these values are summarized in Table 1. It is clearly seen that the effects of three variables have been investigated. To evaluate the effect of each variable, we have added a value of "1" for Material 1 and a value of "2" for Material 2. The Table 1. also contains the measured values (F_t and R_a), these will be later analyzed. A conventional milling machine was used for the experiments because to ensure more accurate measurement results and good accessibility. Because the applied the machine tool has fixed speed (*n*) and feed (*v*_f) rates, the cutting speed was constant. Its value was $v_c=347$ m/min.

It was examined two main parameters during the measurements. One of the tangential cutting force (F_t) and the other is the average surface roughness (R_a) . For force measurements the torque was measured by a KISTLER rotary dynamometer. Because the F_t is a calculated value, it is specified from the torque. A large amount of data were recorded that can be detectable the moment of entry (Fig. 5 b "Zone 3") and exit (Fig. 5 b "1" zone) during the force measurements. The measuring frequency was 30000Hz.



Fig. 7 Experimental set-up

For evaluation of surface roughness, measuring equipment (MITUTOYO Formtracer SV-C3000) was used. The average surface roughness parameters (R_a) were measured in zone "2" (see in Fig. 5b). Furthermore the "1" and "3" zones also were evaluated, but it does not represent relevant values. All measurements were carried out 5 times, the average of these shows the Table 1.

Table 1 Experiment set-up and measured values					
No.	Material	f_{z}	$a_{ m e}$	F_{t}	R_{a}
	[]	[mm/tooth]	[mm]	[N]	[µm]
1	2	0,08	1	127,4	0,552
2	1	0,08	1	123,2	0,232
3	2	0,2	2	202,6	1,042
4	2	0,2	1	140,4	1,146
5	1	0,08	2	157,8	0,285
6	2	0,08	2	155,2	0,755
7	1	0,2	2	240,2	0,203
8	1	0,2	1	154,8	0,421

Table 1 Experiment set-up and measured values
--

3. Evaluating of results

For the evaluations several software were used, such as Minitab Experiment Planner and Evaluation System for graphic evaluations and factorial experimental planning, Microsoft Excel for analytical evaluation and Origin software for fitting the measured values graphically.

3.1. Graphical evaluating

After the correct and thorough designing, a very important element the error-free evaluation. In the interest of it the Minitab statistical evaluation software was used. It is possible to display the results graphically in several ways by this system. The graphical evaluation of the tangential cutting forces is summarized in Fig. 8. Four types of appearance were used. As a result, it can be seen that there was no measurement error and deviation of the results were also appropriate during the measurements.



Fig. 8 Residual plots for tangential cutting forces

A similar evaluation also carried out with the surface roughness. Similarly to the normal distribution, the Fig. 9 shows that the measurements are well done. The results of the surface roughness, as described above, were measured in zone "2", practically where the tool works in a full chips cross section and the workpiece stability is the greatest.



Fig. 9 Residual plots for surface roughness average

The main effects of the factors on the tangential cutting forces and surface roughness values after machining are shown in Fig. 10-11. Clearly visible in the Fig. 10-11, that the f_z and a_e has the greatest effects on tangential cutting forces (F_t), while the quality of the workpiece has the best effects on the surface quality and so the f_z has little effects on the surface quality too.



Fig. 10 Main effects plot of tangential cutting forces



Fig. 11 Main effects plot of surface roughness average

3.2. Analytical evaluating

The next chapter was deal with the analytical evaluation methods. Its essence, to find those sensitive settings which has actually effects on desired value.

First, a regression analysis was carried out. This is summarized in Table 2, where in some cases only the influential values (R-square) were occupied. It is clearly visible that both values (Response) of all variables ("all variables") are sufficiently good values. For both of the requested values (Response) we got good values depending on all variables. This practically means that regression has been successful.

Regression	Response		Variations
	F_{t}	R_{a}	v arrations
D coupro	0,87	0,86	all variables
K-square	0,84		\int only " f_z " " a_e "
		0,74	only "material"

 Table 2 Regression of values

However, if look at Table 3, it is clear that value of F-significant has not the best indicators in case "all variables". Table 4 shows the results of coefficients and p-values. Here we can more clearly see the fact that, why we did not get the best F-significant results in "all variables" case. The p-value in the case of surface roughness the f_z and a_e value are very high, while the Material has very promising result (see in Fig. 11). The values of f_z and a_e have a great effect on tangential cutting forces, while the Material is almost negligible.

From all of these, it is necessary to make a separate regression in cases where only the influencing factors are taken into account. In this case, you can see completely different, more tangible results in Table 3-4.

Table 3 Analysis	of variance (ANOVA)		
ANOVA	Response		Variations
F-significant	F_{t}	R_{a}	F-significant
	0,029	0,031	
	0,0097		-
		0,0064	-

	Coficents	p-value	
Constant	-0,5666666667	0,141223	
Material	0,5885	0,00932*	all variables of R_a
fz	2,058333333	0,119907	
$a_{ m p}$	-0,0165	0,90156	
Constant	-0,30325	0,230634	antermatorial of D
Material	0,5885	0,006408	only material of R_a
Constant	51,98333333	0,188707	
Material	-12,6	0,396717	all mariables of E
f_{z}	363,3333333	0,030469*	all variables of $F_{\rm t}$
$a_{ m p}$	52,5	0,016806*	
Constant	51,98333333	0,188707	
fz	363,3333333	0,030469	only " f_z " and " a_p " of F_t
a _p	52,5	0,016806	

Table 4 Casting and Developed in different and

*significant values!

Taking into account the above facts, we can write the following equations (based on experimental values):

$$Ft = 51,98 + fz^{363,3} + ap^{52,5}$$
(1)

furthermore,

$$Ra = -0,303 + Material^{0,58}$$
(2)

4. Discussion

During the experiments it can be stated that composite materials (not only the polymer-based) are being used in more and more places so it is very important to do researches with this materials [3-5]. Also so important to be know the right technological methods and parameters.

The measurements have also shown that the well-chosen experimental method is important for machining tests. As a result, the results were not scattered and the corresponding values were shown.

We also highlighted, the evaluation should not only be graphic but also be analytical, because it has more accurate value. In addition, we have found that in the case of high-frequency signaling, we can observe those processes which are beyond the normal evaluations. Fig. 12 shows the moment of starting of chip removing. On the inserted curve, it is clearly visible that after the first touch, the forces begin to grow and then become almost constant and then again begin to grow. This will continue until you get the maximum value. This interesting phenomenon can be explained, that the carbide insert does not cutting at the moment of starting of machining, only burnish the surface and when it reaches the limit of the shear strength of the material, it begins the chip removing. This phenomenon could only be achieved by forces alone. In the future we are planning to do vibrations and temperature tests too. We assume that different materials will behave differently, this will be show wider and deeper scene about the chip removing tests.



References

- [1] B. Rajeswari, K.S. Amirthagadeswaran: Experimental investigation of machinability characteristics and multiresponse optimization of end milling in aluminium composites using RSM based grey relational analysis. Measurement 105 (2017), pp.: 78–86
- [2] Sener Karabulut: Optimization of surface roughness and cutting force during AA7039/Al2O3 metal matrix composites milling using neural networks and Taguchi method. Measurement 66 (2015), pp.: 139–149
- [3] Z. Weltsch, A. Lovas: Wettability of Ceramic Substrates by Silver Based Alloys. ACTA PHYSICA POLONICA A Vol 124:(No. 1) (2013), pp.: 78-86
- [4] Z. Weltsch, K Klam, A. Lovas: The Comparison of Hardness and Coercivity Evolution in Various Fe–B Based Glasses (Including FINEMET Precursor) during Relaxation and Crystallization. ACTA PHYSICA POLONICA A 131:(4) (2017), pp.: 669-671
- [5] Z. Weltsch, A. Lovas: The Relation between the Surface Tension and the Bulk Properties of Diluted Silver Based Melts, MATERIALS SCIENCE FORUM Vol. 729 (2013), pp.: 19-24