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Effect of Machining Parameters on Cutting Force and Surface Roughness during Dry Turning of Al6061/Zrb2alumium Matrix Composite

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Abstract:This paper shows that the outcome of analysis by the machining of Al-6061–ZrB2.which has done through in-situ reactions. Al 6061 alloy is reinforced with zirconium diboride by stir casting method.The reaction of K2ZrF6 and KBF4 will form ZrB2 at a temperature of 860°C and a holding time of 45 minutes using in-situ reaction. The molten metal matrix composite is poured into the pre-heated die with diameter of 50mm and length 500 mm. Influence of reinforcement ratio of 0, 5 and 10 wt% of ZrB2 on machinability are examined. By the turning operation cutting force was reduced, when the cutting speed has increased. The increment in ZrB_2 particles within the matrix decreases the cutting force. Surface roughness is enhanced due to improvement in surface roughness and cutting speed deteriorated because of more addition of reinforcement.

Keywords :. Al6061,ZrB_2,MMCs

I. INTRODUCTION

Aluminum alloys are noteworthy for their strong machinability factor and most preferred in automotive and aviation industries because of its characteristics like high strength to its weight ratio, exceptional less performance in temperature and outstanding corrosion resistance, chemical inertness to most often used in cutting tools.[1-3]. MMCs were basically used in fiber reinforced pistons and reinforced cylinder surfaces as well as particle-strengthen brake disks in automotives, notably in the automotive industry [4, 5].MMCs consists of metal matrix and reinforced material or filler material that gives high mechanical performance and could be categorized as continuous or discontinuous reinforcement.

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MMCs with dimensionless reinforcements are generally much cheaper to develop MMCs reinforced with longitudinal fiber. In this project work, the dimensionless reinforcements are used. Zirconium diboride and silicon carbide was introduced as reinforcements. The melting temperature of zirconium diboride is 3245°C and silicon carbide is 273°C. In this present research zirconium diboride is selected as reinforcement, which remarkable enhances the mechanical characteristics of the composite. The stir casting set-up is used to fabricate the insitu composite of Al-ZrB_2. Insitu process is defined by synthesizing the ceramic particles of the halide salts within the molten alloy by the chemical reaction .In-situ synthesize of a ceramic second stage particles gives great influence over the size and amount of reinforcements as well as the architecture of metal matrix reinforcement, leading to better suiting of the composites [13].

In-situ composites have benefits such as being more homogeneous in their microstructure and being thermodynamically more stable as well as having better interfacial bonding between reinforcements and matrices. Turning process includes the use of a lathe and is mainly used for the production of cylindrical or conical parts. With specific devices, curved surfaces can grind flat faces, and boring on a lathe can be done. Strengthening tool life, boosting surface precision, increasing cutting force and chip thickness in turning operations is indeed useful. Surface roughness and cutting force play the most important roles in a turned part's performance among these four characteristics. Cutting speed, feed frequency, cutting length, tool-work piece content, tool configuration and coolant conditions are the turning parameters that have a major impact on performance measurements and on material removal levels and machining quality such as surface quality. For to reach the proper dimensions, the part generated by the composite materials which requires machining process. So, without solving machinability problems.composites would be difficult for industrial application. Surface finish, wear of the tool, cutting temperature. cutting force are the main indices for evaluating the behavior of machinability[19, 20].

II. EXPERIMENTAL SETUP

Aluminium is melted in a graphite crucible to about 840C. The graphite crucible is pre-heated in the pre-heater.

The Al 6061 rods are heated in a crucible to about 840°C and stirred using the stirrer in the stir casting furnace which is shown in Fig.1. The composition of K_2ZrF_6 and KBF_4 salts are added into the crucible and were stirred intermittently for 45 min. The process is an in-situ process meaning the chemical reaction takes place inside the crucible. It has a preheating temperature indicator where the temperature can be set to about 700°C The molten metal Al6061 with ZrB2 ,which is pre-heated which can be takeninto the cylindrical die of diameter 50 mm and length of 500 mm.

The workpiece is fixed in the Kirsloskar made Turnmaster-35 lathe using surface gauges and keys. The machining parameter selected for the turning operation are cutting speed (30, 60 ,90 & 120 m/min) for a constant feed rate (0.12 mm/rev) and depth of cut (0.5 mm). The cutting force was measured using Kistler dynamometer (model no: 9857B). Fz graph in the four graphs displayed by the dynamometer is considered and the Fz value is taken as the cutting force value. The surface roughness has measured by the surface roughness tester which was made by Mitutoyo (model no: SJ-210).

Fig. 1.Stir casting furnace

III. RESULT AND DISCUSSIONS

A. Microstructural Analysis of the AA6061/ZrB2 Composite

ZrB_2 particles are spread at all weight proportions in the matrix equally. The K_2ZrF_6 and KBF_4 reaction with molten aluminum formed different sizes of ZrB_2 particles. Many of the ZrB2 particulates have a spherical shape, some of them have an elliptical form. The in-situ reaction produces very fine nano scaled particles, which combines to form clusters that depends on the temperature of the synthesis, holding time ,rate of cooling and rate of reaction. ZrB_2 particles ' structure, size and physical arrangement have an impact mechanical properties of the composite. ZrB_2 particle distribution in the matrix is linked directly to the matrix alloy solidification process.

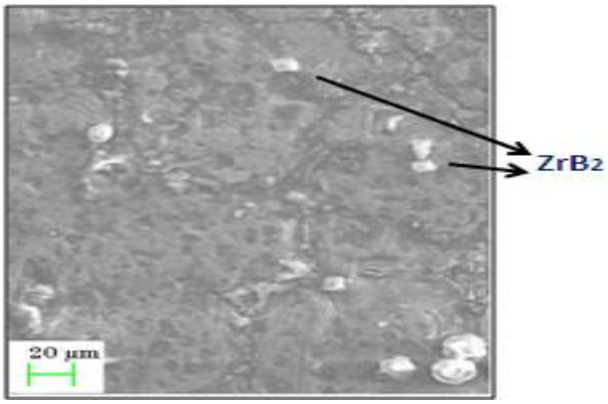

Fig. 2a SEM micrograph of Al6061-5%ZrB2

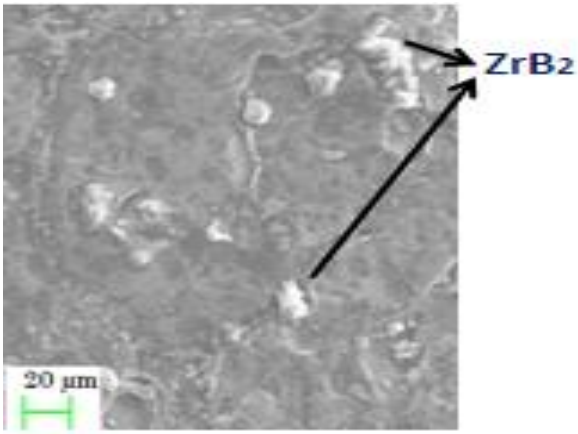

Fig. 2b SEM micrograph of Al6061-10% ZrB2

B. cutting speed on cutting force

From the results proposed it conforms that the cutting force is larger in Al-6061 with 5% ZrB_2 than 10% ZrB_2 reinforcement .Therefore the cutting force is reduced by the increment in ZrB_2 reinforcement ratio. Gain in reinforcement will minimize the build-up edge formation, which shuns the cutting force .As the cutting speed builds up its rpm which gradually effects the chip tool contact length and results the reduced cutting force in each Al 6061 metal matrix composite. Therefore cutting force is reduced by increase in cutting speed.

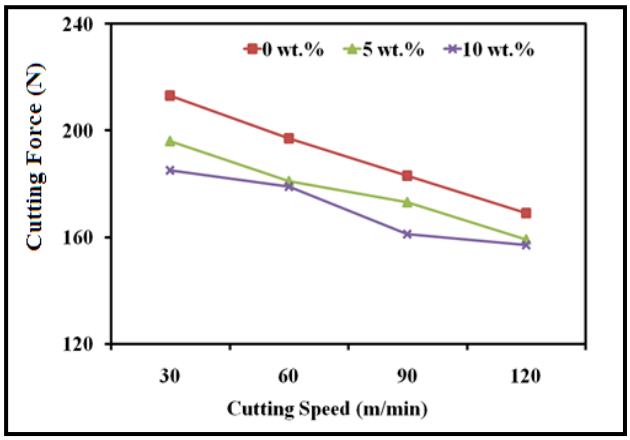

Fig. 3 Cutting speed Vs Cutting Force

IV. CONCLUSION

Al6061 alloys were reinforced with ZrB2 metal matrix composites has been fabricated by the in-situ reaction of K2ZrF6 and KBF4.SEM micrographs clearly revealed the presence of ZrB2. Most of the ZrB2 particles could be in spherical shape and some show elliptical shape. The effect of machinability factors that are cutting speed, feed rate, and depth of cut on, cutting force and surface roughness during turning operation were analysed and the following results have been obtained. From the analysis of means at different levels which shows that adding of ZrB2 reinforcement raises surface roughness and reduces cutting force. The cutting force and surface roughness were less at higher cutting speeds.

REFERENCES

1. Wang, Hongming, Guirong Li, Yutao Zhao, and Gang Chen. "In situ fabrication and microstructure of Al2O3 particles reinforced aluminum matrix composites." Materials Science and Engineering: A 527, no. 12 (2010): 2881-2885.
2. Lijay, K. Jeshurun, J. David Raja Selvam, I. Dinaharan, and S. J. Vijay. "Microstructure and mechanical properties characterization of AA6061/TiC aluminum matrix composites synthesized by in situ reaction of silicon carbide and potassium fluotitanate." Transactions of Nonferrous Metals Society of China 26, no. 7 (2016): 1791-1800.
3. Rajan, HB Michael, S. Ramabalan, I. Dinaharan, and S. J. Vijay. "Synthesis and characterization of in situ formed titanium diboride particulate reinforced AA7075 aluminum alloy cast composites." Materials & Design 44 (2013): 438-445.
4. Rejil, C. Maxwell, I. Dinaharan, S. J. Vijay, and N. Murugan. "Microstructure and sliding wear behavior of AA6360/(TiC+ B4C) hybrid surface composite layer synthesized by friction stir processing on aluminum substrate." Materials Science and Engineering: A 552 (2012): 336-344.5.
5. Selvam, J. David Raja, and I. Dinaharan. "In situ formation of ZrB2 particulates and their influence on microstructure and tensile behavior of AA7075 aluminum matrix composites." Engineering Science and Technology, an International Journal 20, no. 1 (2017): 187-196.
6. RajeshRuban, J. David Raja Selvam, and Rajakumar S. Rai. "Experimental investigation and characterization of in situ synthesized sub micron ZrB2-ZrC particles reinforced hybrid AA6061 aluminium composite." Materials Research Express 6, no. 10 (2019): 1050e1.
7. Selvam, J. David Raja, DS Robinson Smart, and I. Dinaharan. "Microstructure and some mechanical properties of fly ash particulate reinforced AA6061 aluminum alloy composites prepared by compocasting." Materials & Design 49 (2013): 28-34..
8. Dinaharan, I., N. Murugan, and Siva Parameswaran. "Influence of in situ formed ZrB2 particles on microstructure and mechanical properties of AA6061 metal matrix composites." Materials Science and Engineering: A 528, no. 18 (2011): 5733-5740.
9. Selvam, J. David Raja, I. Dinaharan, S. Vibin Philip, and P. M. Mashinini. "Microstructure and mechanical characterization of in situ synthesized AA6061/(TiB2+ Al2O3) hybrid aluminum matrix composites." Journal of Alloys and Compounds 740 (2018): 529-535.
10. Pugazhenthi, A., G. Kanagaraj, I. Dinaharan, and J. David Raja Selvam. "Turning characteristics of in situ formed TiB2 ceramic particulate reinforced AA7075 aluminum matrix composites using polycrystalline diamond cutting tool." Measurement 121 (2018): 39-46.
11. Arsha, A. G., E. Jayakumar, T. P. D. Rajan, V. Antony, and B. C. Pai. "Design and fabrication of functionally graded in-situ aluminium composites for automotive pistons." Materials & Design 88 (2015): 1201-1209.
12. Mahamani, A. "Machinability study of Al-5Cu-TiB2 in-situ metal matrix composites fabricated by flux-assisted synthesis." Journal of Minerals and Materials Characterization and Engineering 10, no. 13 (2011): 1243.
13. Bains, Preetkanwal Singh, Sarabjeet Singh Sidhu, and H. S. Payal. "Fabrication and machining of metal matrix composites: a review." Materials and Manufacturing Processes 31, no. 5 (2016): 553-573.
14. Roshan, M. R., Taherzadeh R. Mousavian, H. Ebrahimkhani, and A. Mosleh. "Fabrication of Al-based composites reinforced with Al2O3-TiB2 ceramic composite particulates using vortex-casting method." Journal of Mining and Metallurgy B: Metallurgy 49, no. 3 (2013): 299-305.
15. Sivasankaran, S., E. Saminathan, S. Sidharth, P. T. Harisagar, and P. Sasikumar. "Effect of Graphite Addition on Surface Roughness during Turning of AA 7075-ZrB2 In-situ Metal Matrix Composites." Procedia Materials Science 5 (2014): 2122-2131.
16. Ozcatalbas, Yusuf. "Chip and built-up edge formation in the machining of in situ Al4C3–Al composite." Materials & design 24, no. 3 (2003): 215-221.
17. Kumar, Ravinder, and Santram Chauhan. "Study on surface roughness measurement for turning of Al 7075/10/SiCp and Al 7075 hybrid composites by using response surface methodology (RSM) and artificial neural networking (ANN)." Measurement 65 (2015): 166-180.
18. Kumar, NG Siddesh, GS Shiva Shankar, M. N. Ganesh, and L. K. Vibudha. "Experimental investigations to study the cutting force and surface roughness during turning of aluminium metal matrix hybrid composites." Materials Today: Proceedings 4, no. 9 (2017): 9371-9374.
19. Baburaj, E., KM Mohana Sundaram, and P. Senthil. "Effect of high speed turning operation on surface roughness of hybrid metal matrix (Al-SiC p-fly ash) composite." Journal of Mechanical Science and Technology 30, no. 1 (2016): 89-95.
20. Duan, Chunzheng, Wei Sun, Mingfan Che, and Wendian Yin. "Effects of cooling and lubrication conditions on tool wear in turning of Al/SiCp composite." The International Journal of Advanced Manufacturing Technology (2019): 1-13.

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