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# A STUDY ON INFLUENCE OF DRILLING PARAMETERS ON SURFACE ROUGHNESS IN MACHINING OF AA2219-$TIB_2$/$ZRB_2$ IN-SITU METAL MATRIX COMPOSITE

P.Reginald Elvis,S.Karthikeyan, M.Ganesan, S.Paramaguru, K.Amarnath
*Department of Mechanical Engineering,*
*Saranathan College of Engineering, Trichy, Tamilnadu, India*

***Abstract-*** **Composite material technology has been developed to explore the best advantage of metallic and ceramic material characteristics. Aluminum matrix composites are attracted many researchers due to its improved mechanical properties and wear resistance with minimal weight. Among the various processing route, flex assisted synthesis is a highly potential and low cost method to produce in-situ composites. In-situ aluminum matrix composite has superior performance than the ex-situ composite because of the chemically dispersed reinforcements. The reinforcement phase created by this route is thermodynamically stable and chemically pure. These composites offer many advantages, including more bonding strength, fine, lack of agglomeration and uniform distribution of reinforcements. As a result, the mechanical properties, such as strength and stiffness, increase significantly. In the present work, flex assisted synthesis process is used to produce AA2219 - $TiB_2$/$ZrB_2$ in-situ aluminum matrix composite with the different reinforcement ratio. The present paper is aimed to study the effect of speed, feed rate, drill bit diameter and point angle on surface roughness in drilling the AA2219 - $TiB_2$/$ZrB_2$ in-situ aluminum matrix composite with the different reinforcement ratio. The experimental investigation was carried out to study effect of one machining parameter, other parameters are kept constant. The major contribution of this work was to study the effect of hybrid TiB2 and ZrB2 reinforcements in AA2219 alloy in drilling the composites.**

***Index Terms-*** **Surface roughness, In-situ composite, multiple reinforcements**

## I. INTRODUCTION

The component produced by the composite materials requires machining process to achieve desired dimension and surface finish. The increasing application of metal matrix composite for structural and wear resistance component in aerospace, automotive and recreational fields necessitated an in depth analysis of machined surface, which determines the ability of the material to withstand severe conditions of stress, temperature, corrosion and controls its durability and reliability. The machined surface quality of the composite is one of the most important factors affecting the actual application of the composites. Plastic deformation of the fine particle composite more uniform therefore low tool wear and lower cutting temperature. There is no recast layer is formed on the surface and machined surface layer is work hardened. However there is a challenge exists to achieve the composites material with fine and small size ceramic particles. The metal matrix composites fabricated by in-situ route has gained considerable attention for its superior performance. Metal matrix composites produced by the conventional method have the lack of distribution of reinforcements, poor wetting, agglomeration of reinforcements and low interfacial strength [1]. Such technology is confined by adding reinforcement particulates in the molten matrix. In in-situ technique, the reinforcement is formed in the host matrix via chemical reaction between matrix and reinforcements [2]. These composites offer many advantages, including more bonding strength, fine, lack of agglomeration and uniform distribution of reinforcements. As a result, the mechanical properties, such as strength and stiffness, increase significantly [3].Aluminum alloy AA2219 is a high strength alloy most widely used for aerospace applications, cryogenic rocket fuel tank and light weight structures [4]. The machinability characteristics of the ex-situ composites are well established in literatures [5-8].Mahamani et al (2010) reported the synthesis, quantitative elemental analysis, micro-structure characteristics and micro-hardness analysis of AA2219-TiB2/Zrb2 in-situ metal matrix composite.Very few authors are investigated the machinability behavior of in-situ metal matrix composites.

Basavarjappa et al. (2008) presented the influence of cutting parameters on thrust force, surface finish and burr formation in drilling A12219/15Sicp and A12219/15 Sicp-3gr composites, using the tools carbide and coated carbide drills. They revealed that feed rate had a major influence on thrust force, surface roughness and exit burr formation.

Paulo Davim et al (2004) studied cutting parameters (cutting velocity and feed rate) under the techniques of Taguchi. The analysis of variance (ANOVA) was performed to investigate the cutting characteristics of GFRP'S using cemented carbide (K10) drills. As a function of using cutting parameters, it was possible to predict surface quality.

Nihat Tosun (2006) proposed a grey relational analysis to predict the optimal drilling parameter. The various drilling parameters such as feed rate, cutting speed, drill and point angles of drill were considered. Optimal machining parameters were determined by the grey relational grade obtained from the grey relational analysis for multi performance characteristics. They found that the surface roughness and the burr height in drilling process can be improved effectively.

Paulo Davim (2003) presented a study on influence of cutting velocity and cutting time on drilling metal-matrix composites using drill bit .A plan of experiments were based on Taguchi orthogonal array. The objective was to establish correlation between cutting velocity, feed rate and cutting time inorder to evaluate the tool wear, specific cutting pressure and the holes surface roughness. These correlations were obtained by multiple linear regression.

Tasun, Muratogue (2004) studied the surface integrity of drilled Al/17% SiC particulate MMCs by using HSS, TiN coated HSS and solid carbide drills. Dry drilling tests at different spindle speeds, feed rates, point angles of drill and heat treatment were conducted in order to investigate the effect of various cutting parameters on surface quality and extend of deformation of drilling. It was observed that increase in drill hardness and feed rate decrease surface roughness of drilled surface for all heat treated condition.

Tsao (2007) studied thrust force and surface roughness of core drill with drill parameters (grit size of diamond, thickness, feed rate and spindle speed) in a drilling carbon fiber reinforced plastic (CFRP) laminate experimentally studied by using Taguchi method. The confirmation tests demonstrated a feasible and an effective method for evaluation of drilling-induced thrust force and surface roughness (errors with 10%) in drilling of composites materials.

Noorul Haq et al (2008) proposed a multiple response optimization using grey relational analysis in drilling of SiC composites. Cutting speed, feed rate and point angle are considered as machining parameter. They found that the responses in drilling process can be improved effectively through this approach.

Ozcatalbas (2003a) carried out an experimental investigation on machinability behavior of Al-Al4C3 in-situ composites. The micro crack propagation at particle-matrix interface facilitates the fracturing through the chip cross section this effect reduce the cutting force. The homogeneous microstructure and high hardness of the composite reduce the build up edge formation that improves the surface roughness.

Ozcatalbas (2003b) investigated the chip and buildup edge formation in machining of the in-situ Al-Al4C3 composites. The morphologies of chip routes were determined by using the quick stop device. It was observed that the small size particle and high hardness of the composite cause discontinuous chip formation and increasing the chip cutting ratio.

Rai et al. (2006) conducted the experiments on machining of Al-TiC in-situ composite. They reported the chip formation and cutting force measurements during shaping operation. High volume fraction of the TiC particles causes discontinuous and favorable chip formation without any build up edge formation. The cutting force was minimized due to the propagation of micro cracks at particle-matrix interface. Size and morphology of the TiC particle present in the composite have been found to influence surface roughness.

Anandakrishnan and Mahamani (2010) investigated machinability of the in-situ Al6061-TiB2 composites. They reported the effect of speed, feed and depth of cut on flank wear, cutting force and surface roughness. It was observed that presence of small and fine TiB2 particles have offered significant influence on machinability.

The literature review shows that the Drilling characteristics of the in-situ composites with multiple ceramic reinforcements were not addressed. Therefore an attempt has been made to study the influence of drilling parameters on surface roughness in machining the AA2219- $TiB_2/ZrB_2$ in-situ metal matrix composite.

## II. MATERIALS AND METHOD

AA2219 was selected as a matrix material for the study. The chemical composition of the matrix was shown in Table -1. AA2219 alloy was reinforced with TiB2 and $ZrB_2$ reinforcement particles. Flux assisted synthesis method was followed to fabricate the composites. Three types of halide salt, namely potassium hexafluorotitanate ($K_2TiF_6$), potassium hexafluorozirconate ($K_2ZrF_6$) and potassium tetrafluroborate (KBF4) were used to synthesize the composites.

During experiments, only one parameter was varied while others were held constant to observe the effects of variation of an individual input parameter on the output parameter.

Speed, feed rate, drill bit diameter and point angle are considered as considered as machining parameters. The response to be studied here is surface roughness (Ra). The level of the machining parameters is given in the table 2. SJ210 surface roughness tester was used for this study. The travel speed of the 0.5mm/s and measured length is 7.5 mm.

Table 1 Chemical composition of AA2219 alloy

| Material | Cu | Mn | Fe | Zr | V | Si | Ti | Zn | Al |
|---|---|---|---|---|---|---|---|---|---|
| Wt. % | 6.33 | 0.34 | 0.13 | 0.12 | 0.07 | 0.06 | 0.04 | 0.02 | bal |

Table.2. Factors and levels of experimental work

| Factor | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Spindle speed(rpm) | 695 | 1200 | 2000 | 3390 |
| Feed rate(mm/rev) | 0.05 | 0.10 | 0.15 | 0.20 |
| Point Angle(°) | 100 | 110 | 120 | 130 |
| Drill bit diameter | 6 | 8 | 10 | 12 |

## III. EXPERIMENTAL WORK

The experimental work was carried out in Radial Drilling Machine (Suraj make). The HSS drill bit was clamped with chuck. The length of drilling is 12mm. All the experiments are carried out in dry condition. From the experimental investigation the following graph are drawn (fig 2-5)

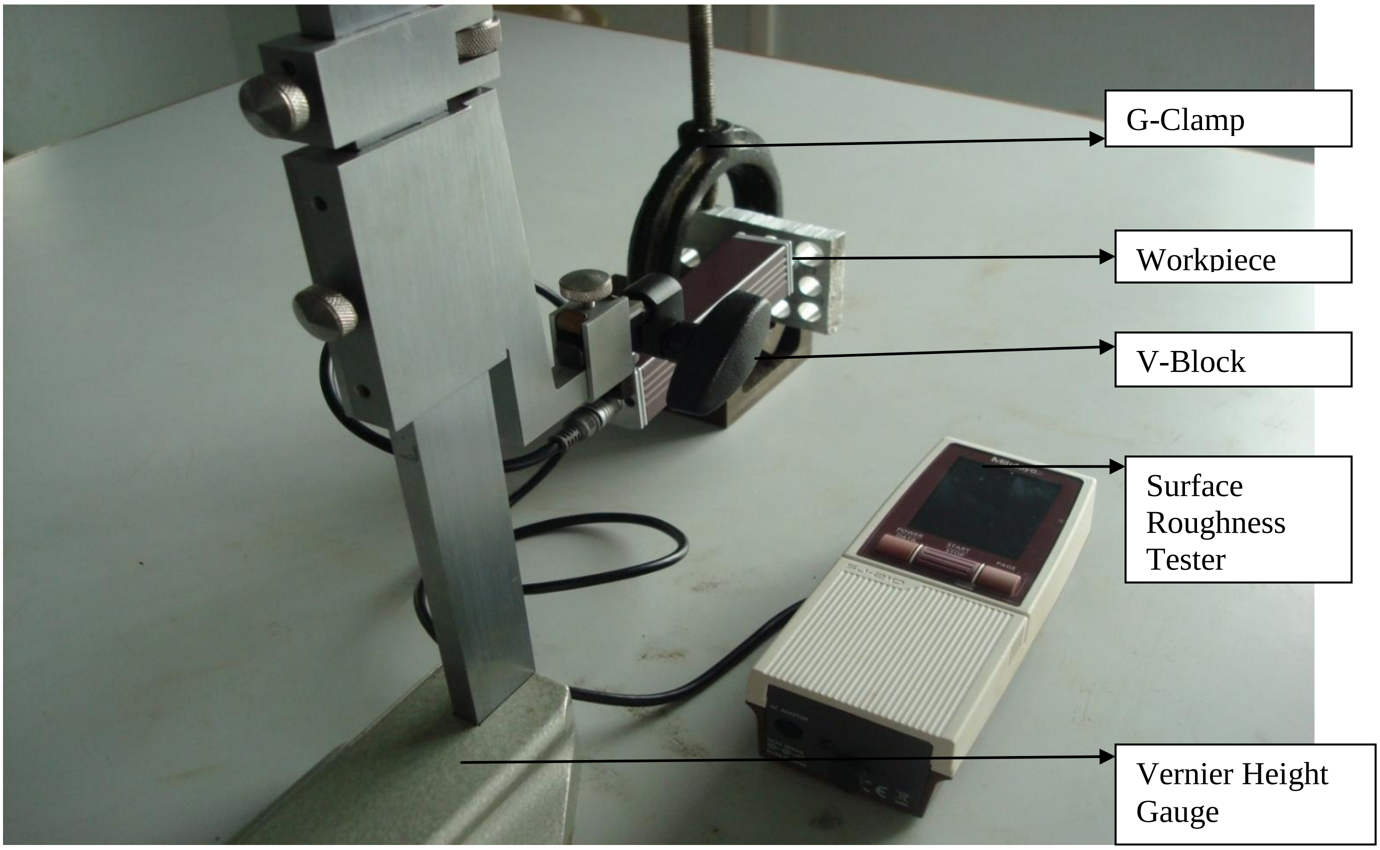


Figure 1 Photographic view of surface roughness measurement

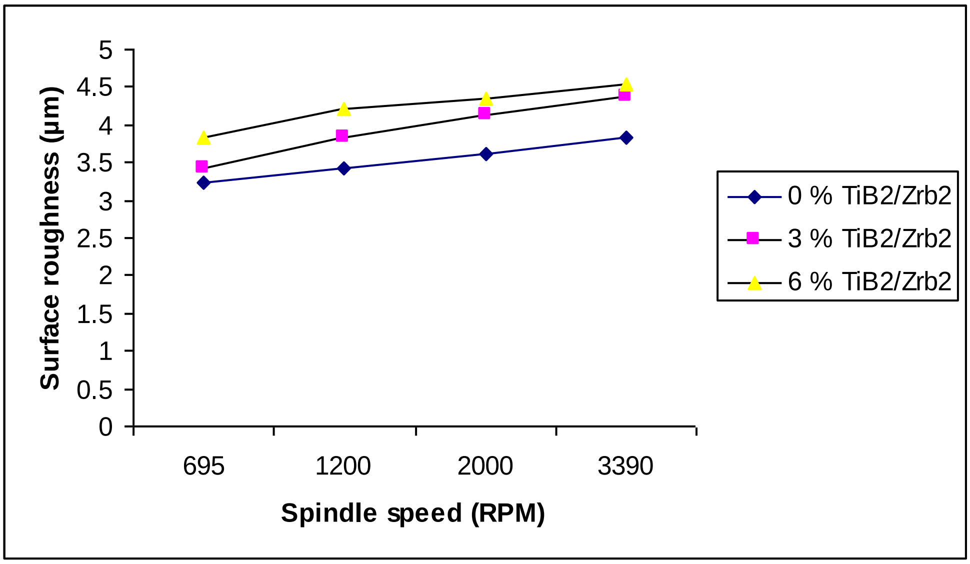


Figure 2 Effect of spindle speed on surface roughness

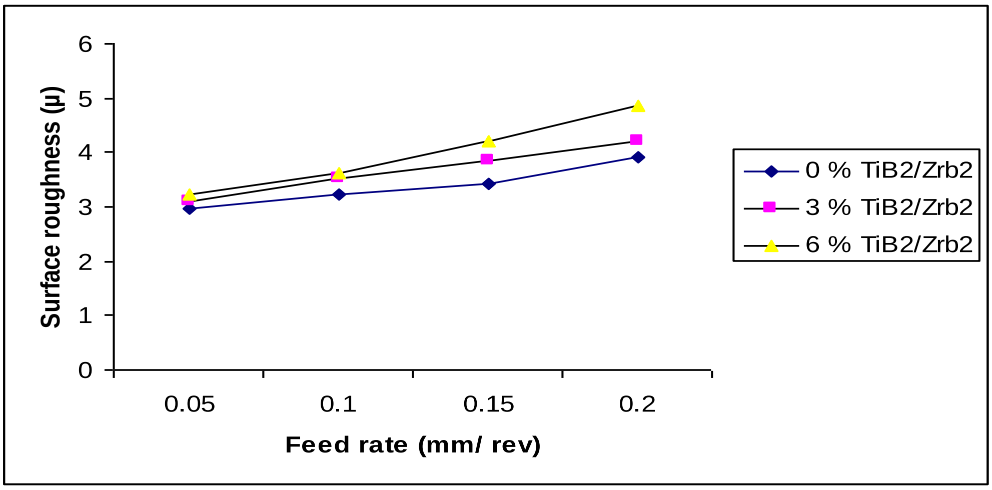


Figure 3 Effect of feed rate on surface roughness

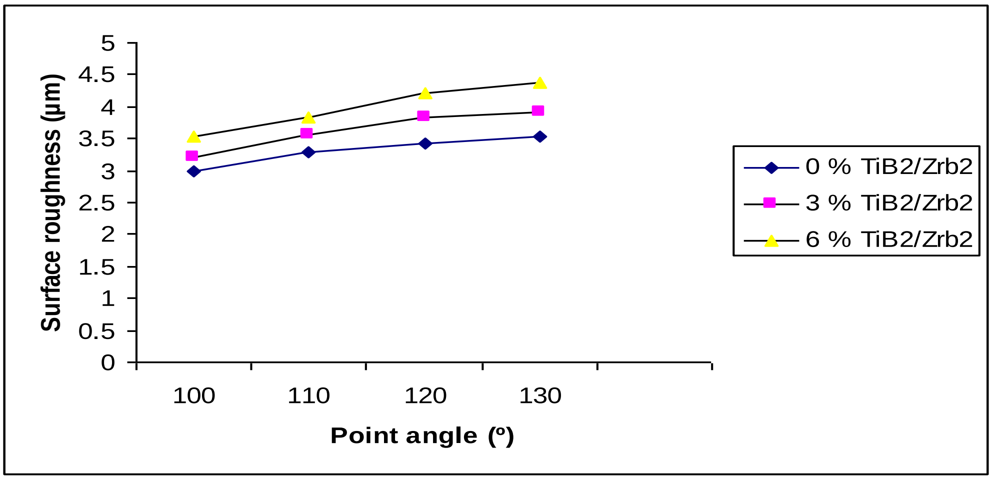


Figure 4 Effect of point angle on surface roughness

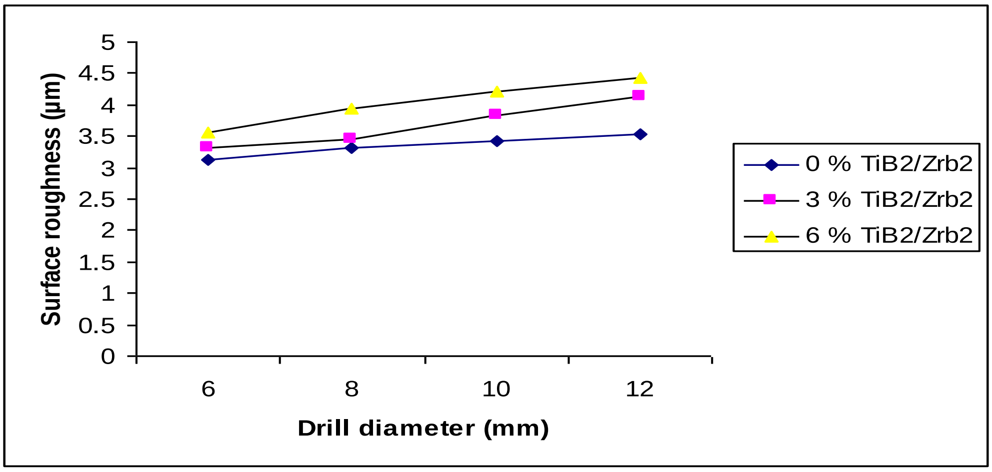


Figure 5 Effect of drill diameter on surface roughness

## IV. RESULTS AND DISCUSSION

The influence of spindle speed on surface roughness was evaluated by keeping the feed rate 0.15 mm/rev, drill diameter of 10mm and point angle 120 º. The figure 2 shows that increase in spindle speed increase the surface roughness of holes. At higher spindle speed, increase the tool vibration which causes scratches on drilled surface. The effect of feed rate on surface roughness was shown in figure 3. The speed of the spindle 1200 rpm, drill diameter of 10mm and point angle 120 º was maintained while doing experiments. Increase in feed rate increase the surface roughness of the holes. Higher feed rate increase the load on the drill cutting edge and leads to high surface roughness. The tool geometry on the surface roughness was shown in figure 4. These experiments are carried out at spindle speed of 1200 rpm, drill bit diameter of 10mm and 0.15 mm/rev with variable point angle. The point angle of 100 º drill has lower surface roughens value than the other angles. Higher point angle increase the area of contact which increase the surface roughness. Figure 5 show that the increase in drill bit diameter increases the surface roughness. Increase in drill diameter increase the material removal rate and causes poor surface finish. It is also observed from the figures 2-5 the increase in reinforcement ratio increase surface roughness.

## V. CONCLUSION

The following conclusions are drawn from the experimental investigation of drilling of AA2219-$TiB_2/ZrB_2$ in-situ metal matrix composites. Increase in spindle speed decrease the surface roughness of holesThe surface roughness value increases by increasing the feed rate The point angle of 100 º drill has lower surface roughens value than the other angles Increase in reinforcement ratio increase surface roughness Further investigation need to be carried to find reasons for the above said conclusions.

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