Original Article

A Novel Detection of surface roughness for AA 6063 using Tungsten Carbide coated tool in comparison with Uncoated tool using surface roughness tester

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Abstract

Aim: The objective of this research is to identify the Surface roughness of AA 6063 by drilling in Novel CNC drilling using the Tungsten Carbide coated tool and Uncoated tool. The Mitutoyo tester was used for determining the surface roughness for machined samples. **Materials and Methods:** The Tungsten Carbide coated and Uncoated tools were used for machining the AA 6063 at a length of 20 mm and a diameter of 25 mm. The G - power calculator of 80% is used for finding the sample quantity. A total of 20 samples were machined for two groups, namely control and intervention groups. The ASTM standard method was used for finding the surface roughness in the SJ410-Mitutoyo Surface roughness tester. **Results:** According to this research, the obtained Surface roughness mean values for AA 6063 samples using the Tungsten Carbide coated tool was 0.84275 μm and the samples machined using the Uncoated tool was 1.9502 μm. The One-Way Analysis of Variance (ANOVA) in SPSS software was used for statistical calculation and the obtained significance level was p= 0.020 (p <0.050). **Conclusion:** Within the limitations of this research, the samples drilled using the Tungsten Carbide tool must have lower surface roughness than the Uncoated tool.

Keywords: Novel CNC drilling, AA 6063, Tungsten carbide coated tool, Uncoated tool, Surface Roughness, Analysis of Variance (ANOVA) test, SPSS software.

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INTRODUCTION

This research focuses on comparing the machining performance of Tungsten Carbide coated and uncoated drills in AA 6063 samples and detecting the Surface roughness in Novel CNC drilling operation (Chaanthini, Murugappan, and Arul 2017). The production of Metal Matrix Composites (MMC) has become larger all over the world, because of its various advantages. Aluminum is the most commonly used material for manufacturing all structural, non-structural, and functional applications in engineering sectors (Filippov et al. 2020). Various researchers have researched the optimization of Aluminum alloy by increasing its quality throughout these years (Cai, Wang, and Yuan 2017). The drilling operation is one of the important processes in manufacturing sectors for the production of holes. It is one of the difficult processes to produce a good surface finish by drilling. Therefore, by reducing speed and feed parameters, it can be controlled. It can also be used as extrusion in industries (Yang et al. 2021).

Based on research over the past 5 years, the papers related to the machining of Aluminum were found to be around 850 papers in ScienceDirect and 1300 papers in Google Scholar. The determination of performance and surface roughness of AA6063-T6 in CNC turning using the WA SPAS approach (Sahoo et al. 2018). The optimization of MRR and surface roughness in AA6063 using the Taguchi method (Shekar 2019). Multi-response optimization of Carbide tool wears in AA6063 using Taguchi Grey Relational Analysis (Achuthamenon Sylajakumari, Ramakrishnasamy, and Palaniappan 2018). Optimization of the performance of CNC turning operation in Aluminum 7075 Alloy using L27 Array-based Taguchi method (Akhtar et al. 2021).

Analysis of surface roughness in CNC turning AA6063-T6 and Inconel 718 using Taguchi method and ANOVA analysis (Pawar 2016).
Our team has extensive knowledge and research experience that has translate into high quality publications (Bhansali et al. 2021; Jayanth et al. 2021; Sudhakar, Ravel, and Perumal 2021; Sathiyamoorthi et al. 2021; Deepanraj et al. 2021; Raju et al. 2021; Arun Prakash et al. 2020; Kamath et al. 2020; Shanmugam et al. 2021; Rajasekaran et al. 2020; Adhinarayanan et al. 2020; Rajesh et al. 2020; Aurtherson et al. 2021). The research papers related to the machining of aluminum alloy with Tungsten Carbide and Uncoated tool determining Surface roughness were not found. This study was focused on the efficiency of the tool and the depth of the hole in Novel CNC drilling operations.

Materials And Methods

The preparation of samples and Novel CNC drilling of samples as per design were carried out at Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Chennai, utilizing the facilities in the Department of Mechanical Engineering. The aluminum alloy of grade 6063 was used for machining in Novel CNC drilling operations. The Tungsten Carbide coated and Uncoated tools were used for drilling. The experimental setup of the Novel CNC drilling machine was shown in Fig. 1. The sample size of 20 in each group was calculated in g-power of 80% test power standard deviation is 0.561 and mean value is 1.39 (Dashti et al. 2018). A total of two groups (control and intervention group) were used for this study.

In the intervention group, an AA 6063 of 25mm diameter was parted to the length of 20mm. The Tungsten Carbide coated tool of 8mm diameter was used for machining the samples by changing the drilling parameters in the Novel CNC drilling machine. For obtaining a good surface finish, the feed rate is lowered. The Tungsten Carbide tool was shown in Fig. 2. A total of 20 samples were machined. Fig. 3 shows the machined samples using the Tungsten carbide tool.

In the Control group, an AA 6063 of 25mm diameter was parted to the length of 20mm. The Uncoated tool of 8mm diameter was used for machining the samples. The Uncoated tool was shown in Fig. 4. A total of 20 samples were machined. Fig. 5 shows the machined samples using the Uncoated tool.

The machined samples were tested in (SJ410 - Mitutoyo) surface roughness tester. The testing process is done by comparing the samples of the intervention and control groups. The surface roughness tester was shown in Fig. 6. A total of 40 samples were tested.

The values were collected using the Surface Roughness tester and the needle was made to detect the surface of the samples. Then the measured Surface roughness (μm) values were noted.

Statistical analysis

In this research, the SPSS software from IBM was used for the analytical test. The One-Way Analysis of Variance (ANOVA) test method was used. The test method was done by comparing the surface roughness values of the intervention and control groups. The spindle speed and the feed were independent variables and the surface roughness values were dependent variables (Kumar, Ranjan, and Paulo Davim 2020).

Results

From this study, the surface roughness obtained for samples machined using the Tungsten Carbide coated tool is lower than the samples machined using the Uncoated tool. The surface roughness test results for the intervention and control groups were shown in Table 1. The statistical descriptives for both groups were shown in Table 2. The mean values of Tungsten Carbide and Uncoated tools were 0.84275 μm and 1.9502 μm. Table 3 shows the obtained significant results of the One-Way Analysis of Variance test. The significance value of p= 0.020 ($p < 0.050$) was obtained. The mean difference between the Tungsten Carbide and Uncoated tools was shown as a bar graph in Fig. 7. The mean error bars of 95% and ± 1 for standard deviation error have been obtained.

Discussion

A higher surface finish is obtained, when samples were machined using the Tungsten Carbide tool. The mean values of 0.84275 μm and 1.9502 μm were obtained from the descriptive-analytical results (Table 2). The one-way ANOVA test shows a significant value of 0.020 for 40 samples (Table 3).

The Tungsten Carbide-coated tools were hard and brittle. It also has more efficiency and produces the material with a good surface finish. Less vibration would be produced during machining (Veeresh Kumar et al. 2019). The surface roughness was measured in aluminum alloy 6063 T6 using a Solid carbide tool of 10mm diameter and135^0 helix angle that has produced 0.520 μm (Gadhiya 2019). The spindle speed of 1000 - 2500 (rpm) and the feed rate of 1 - 5 (mm/rev) were varied for machining in the Novel CNC drilling operation. The obtained mean surface roughness for the AA 6063 T6 was 0.650 μm (Zhao et al. 2021). When the material was drilled at 2000 (rpm) with a feed rate of 5 (mm/rev), the surface roughness was increased to 0.932 μm (Ulaş 2019). The minimization of feed rate plays an important role in the optimization of surface roughness. The T-test shows the accurate result for the surface roughness of Aluminum alloy 6063 T6 (Totten, Tiryakioglu, and Kessler 2018).

The drilling of samples with coated and uncoated tools shows only a minor difference in this study. The formation of burr's at the corners of the sample during drilling operation was the major restriction of this study. The surface roughness can be improved by a change of parameters and tools as future work.

Conclusion

Within the limitations of this research, the identification of Surface roughness for AA 6063 samples machined in Novel CNC drilling operation with the Tungsten Carbide tool produced the value of 0.84275 μm and the samples machined using the Uncoated tool produced 1.9502 μm. According to the Analysis of Variance (ANOVA) test, the mean significance of samples machined using the Tungsten Carbide and the Uncoated tool is $p= 0.020$ ($p <0.050$). Thus the obtained value for AA 6063 samples machined with the Tungsten Carbide tool has produced lower Surface roughness when compared to the Uncoated tool.

DECLARATIONS:

Conflict of Interests

The authors of this paper declare no conflict of interest

Authors Contribution

Author RV assisted with data collection, data analysis, and manuscript writing. Author MR was involved in the manuscript's conceptualization, data validation, and critical review.

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TABLES AND FIGURES

Table 1. Obtained values for samples drilled with the Tungsten Carbide and Uncoated tool in the Novel CNC drilling operation using Surface roughness tester.

S. NO.	**SURFACE ROUGHNESS, Ra FOR THE UNCOATED TOOL (µm)**	**SURFACE ROUGHNESS, Ra FOR THE TUNGSTEN CARBIDE TOOL (µm)**
1	1.925	0.835
2	1.932	0.811

3	1.954	0.853
4	1.965	0.806
5	1.969	0.851
6	1.962	0.839
7	1.948	0.826
8	1.935	0.858
9	1.924	0.814
10	1.931	0.891
11	1.927	0.817
12	1.963	0.863
13	1.977	0.874
14	1.998	0.802
15	1.937	0.889
16	1.918	0.819

17	1.953	0.833
18	1.954	0.849
19	1.942	0.873
20	1.989	0.852

Table 2. Descriptive table represents the mean and standard deviation for the Tungsten Carbide tool and the Uncoated tool for 40 samples.

Descriptives								
Surface roughness								
	N	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**
					Lower Bound	**Upper Bound**		
Uncoated tool	20	1.9502	.022354	.004999	1.93969	1.96061	1.918	1.998
Tungsten Carbide tool	20	.8427	.026971	.006031	.83013	.85537	.802	.891
Total	40	1.3964	.561287	.088747	1.21694	1.57596	.802	1.998

Table 3. One-way Analysis of Variance (ANOVA) test represents the significance value for 40 samples. It is observed that on performing One-Way ANOVA, there is a statistical significant difference for surface roughness (p= 0.02, p<0.05).

ANOVA					
SURFACE ROUGHNESS					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	12.263	1	12.263	19986.328	.020
Within Groups	.023	38	.001		
Total	12.287	39			

Fig. 1. Super Jobber Novel CNC drilling machine

Fig. 2. 8mm Uncoated tool.

Fig. 3. 8mm Tungsten Carbide coated tool.

Fig. 4. Samples machined using Uncoated tool.

Fig. 5. Samples machined using the Tungsten Carbide tool.

Fig. 6. Mitutoyo Surface Roughness Tester.

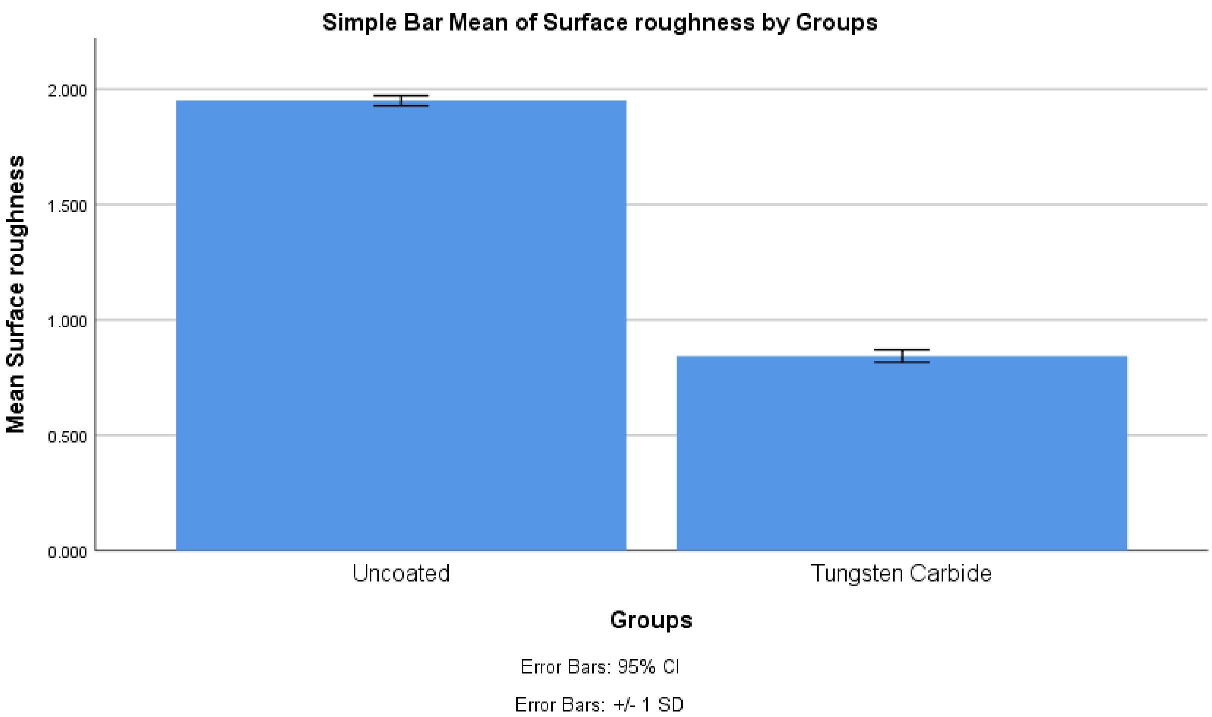

Fig. 7. Bar chart showing the differentiation of mean values of Surface roughness between samples machined using Tungsten Carbide coated drill and Uncoated drill. The average mean of AA 6063 samples machined using Tungsten Carbide coated drill does not have a major difference compared to the AA 6063 samples machined using an Uncoated drill. X-axis: Mean Surface roughness of AA 6063 samples machined with Tungsten Carbide coated drill vs Uncoated drill. Y-axis: Mean values of groups ± 1 SD and error bars of 95% CI.