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INVESTIGATION OF SURFACE QUALITY ON TITANIUM ALLOY USING COATED MILLING CUTTERS

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ABSTRACT

In machining operations, achieving desired surface quality features of the machined product, is really a challenging job on CNC machine. Because, these quality features are highly correlated and are expected to be influenced directly or indirectly by the direct effect of process parameters. In modern industry the goal is to manufacture low cost, high quality products in short time.Automated and flexible manufacturing systems are employed for that purpose along with CNCmachines that are capable of achieving high accuracy and very low processing time. Surface roughness is a measure of the technological quality of a product and a factor thatgreatly influences manufacturing cost. It describes the geometry of the machined surface andcombined with the surface texture, which is process dependent, can play an important role on theoperational characteristics of the part (e.g. appearance of excessive friction and/or wear). Theachievement of a desirable value is a repetitive and empirical process that can be very timeconsuming. The part must be machined more than once until an acceptable value is obtained.However, the extents of significant influence of the process parameters like speed, feed, and depth of cut are different for different responses. Improve the surface quality of work material by using coated inserts.To reduce the tool wear on milling cutters.To minimize the process steps by Optimize the parameters for quick response of conclusion to introduce tool coatings "Latuma&Pertura" To compare the machinability of Titanium specimen.

INTRODUCTION

Titanium was first identified as a new and unknown metallic element by Gregory in England (1791), and was named titanium several years later (1795) by klapproth in Germany after the titans of the Greek mythology. The production of high-purity titanium proved to be difficult, because of the strong tendency of this metal to react with oxygen And nitrogen. Therefore, it was not until the middle of the 20th century (1938-1940) that a commercially attractive process was developed by w.j. Kroll in Luxemburg. This Process involves the reduction of titanium tetrachloride with magnesium in an inert-gas Atmosphere. The resulting titanium is called "titanium sponge" because of the porous, Spongy appearance. The commercial interest in titanium and its alloys was prompted by the relatively low density of this metal (between those of aluminium and iron) in Combination with a high yield strength (especially in the 200-450°c range), and its Excellent corrosion resistance. Therefore, titanium and its alloys are used primarily in two Areas of applications: corrosion resistant areas, such as the chemical industry, and in areas where weight-savings and high strength are predominant, such as in aircraft and Aerospace applications. This introductory section is not intended to give an in-depth Overview on the basic properties of titanium, but only to briefly summarize some of the Findings which are important with regard to the main subject of this chapter on Microstructure/property relationships of titanium alloys. The existing literature on titanium alloys is well documented in the proceedings of The international conferences on titanium, which were held with one exception every Four years: 1968 in london [1], 1972 in boston [2], 1976 in moscow [3]. Heat generated in machining operation is an important factor in addressing metal cutting issues like dimensional accuracy, surface integrity and tool life. In machining of hardened steels, higher workpiece hardness generates higher temperature in the cutting zone (Chinchanikar et al., 2013) which has a very strong influence on the tool wear rate through various tool wear mechanisms like abrasion, adhesion and diffusion. Therefore, evaluation and development of a mathematical model which can predict reliably average chip-tool interface temperature during machining considering the effect of cutting parameters for the given tool-work material combination will be extremely valuable. Over the past century, several conduction techniques like tool-chip thermocouple, embedded thermocouple, thermo-colours and radiation techniques like infrared thermometry, pyrometer have been developed to evaluate the chip-tool interface temperature arising in the cutting zone during machining.

LITRATURE REVIEW

CatalinIulianPruncua,d, Mariana Braic b, Karl D. Dearn a, CosminFarcau c, Robert Watson d, Lidia RuxandraConstantin b, MihaiBalaceanu b, ViorelBraic b, AlinaVladescu b,*: TiCN exhibited the best tribological performance at 250 C, while at ambient temperatures it was TiNbCN. Abrasive and oxidative wear was found to be the main wear mechanism for all of the coatings. Of the tested coatings, TiNbCN coatings would be the most suitable candidate for severe service (high temperature, corrosive, etc.) applications.
Jan C. Auricha, Tina Eyrischa* and Marco Zimmermanna: The effect of coating systems on the tool performance when turning heat treated AISI 4140 is outlined in this paper. Therefore, four differently coated cemented carbide indexable inserts and tools of uncoated cemented carbide, serving as a reference for the capability of the coating systems, are used.
SatishChinchanikara,*, S.K. Choudhuryb: In the present context of sustainable manufacturing, investigation of cutting temperature during machining is extremely valuable to address metal cutting issues such as dimensional accuracy, surface finish and tool life. In this study, average chip-tool interface temperature was investigated considering the effect of cutting parameters and the type of coating (coated tools), namely, PVD- applied single-layer TiAlN and CVD-applied multi-layer TiCN/Al2O3/TiN during turning of hardened steel. Mathematical model which can predict the average chip-tool interface temperature was developed based on experimental observations which were obtained in the wide range of cutting conditions. **Rajesh Kumar Bhushan&Sudhir Kumar & S. Das:** In the present study, an attempt has been made to investigate the influence of cutting speed, depth of cut, and feed rate on surface roughness during machining of 7075 Al alloy and 10 wt.% SiC particulate metal-matrix composites. The experiments were conducted on a CNC **Turnad L. Ginta, A.K.M. Nurul Amin, A.N.M Karim, Anayet U. Patwari:** This paper presents an

approach to establish models and the efforts in optimization of tool life and surface roughness in end milling of titanium alloy Ti–6Al– 4V using uncoated WC- Co inserts under dry conditions. Response surface methodology coupled with small central composite design (CCD) was employed in developing the tool life and surface roughness models in relation to primary cutting parameters such as cutting speed, axial depth of cut and feed. Flank wear has been considered as the criteria for tool failure and the wear was measured under a Hisomet II Toolmaker's microscope. **PriyabrataSahooa*, AshwaniPratapb and AsishBandyopadhyayc:** This investigation has been carried out through a case study in CNC turning of Aluminum alloy 63400 for surface roughness (Ra) and tool vibration (db) optimization. Primarily, input parameters such as spindle speed (N), feed rate (S) and depth of cut (t) are designed for experiment by using RSM Box-Behnken methodology. The aluminum alloy workpieces are machined by using coated carbide tool (inserts) in dry environment. Secondly, the empirical model for the responses as the functions of cutting parameters are obtained through RSM technique and the adequacy of the models have been checked using analysis of variance (ANOVA). **A. Sinlah, D. Handayani, R. C. Voigt, K. Hayrynen, R. M'Saoubi& C. Saldana:** Improving the machinability of austempered ductile irons (ADIs) after heat treatment is a key driver for the further developmentanduseofADI.Theuniqueausferritematrix structure in ADI provides strength and toughness levels that cannot be achieved with the conventional grades of ductile iron. This permits designers to substitute ADI for high performance ferrous and non-ferrous materials in a wide variety of engineering applications.

MATERIAL SELECTION

Work Material Titanium

Titanium was first identified as a new and unknown metallic element by Gregor inEngland (1791), and was named Titanium several years later (1795) by Klapproth inGermany after the Titans of the Greek mythology. The production of high-puity titaniumproved to be difficult, because of the strong tendency of this metal to react with oxygenand nitrogen. Therefore, it was not until the middle of the 20th century (1938-1940) thata commercially attractive process was developed by W.J. Kroll in Luxemburg. Thisprocess involves the reduction of titanium tetrachloride with magnesium in an inert-gasatmosphere. The commercial interest in titanium and its alloys was prompted bythe relatively low density of this metal (between those of aluminium and iron) in combination with a high yield strength (especially in the 200-450°C range), and itsexcellent corrosion resistance. Therefore, titanium and its alloys are used primarily in twoareas of applications: corrosion resistant areas, such as the chemical industry, and in areaswhere weight-savings and high strength are predominant, such as in aircraft and aerospace applications. This introductory section is not intended to give an in-depthoverview on the basic properties of titanium, but only to briefly summarize some of thefindings which are important with regard to the main subject of this chapter onmicrostructure/property relationships of titanium alloys.

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TOOL MATERIAL

HIGH SPEED STAINLESS STEEL

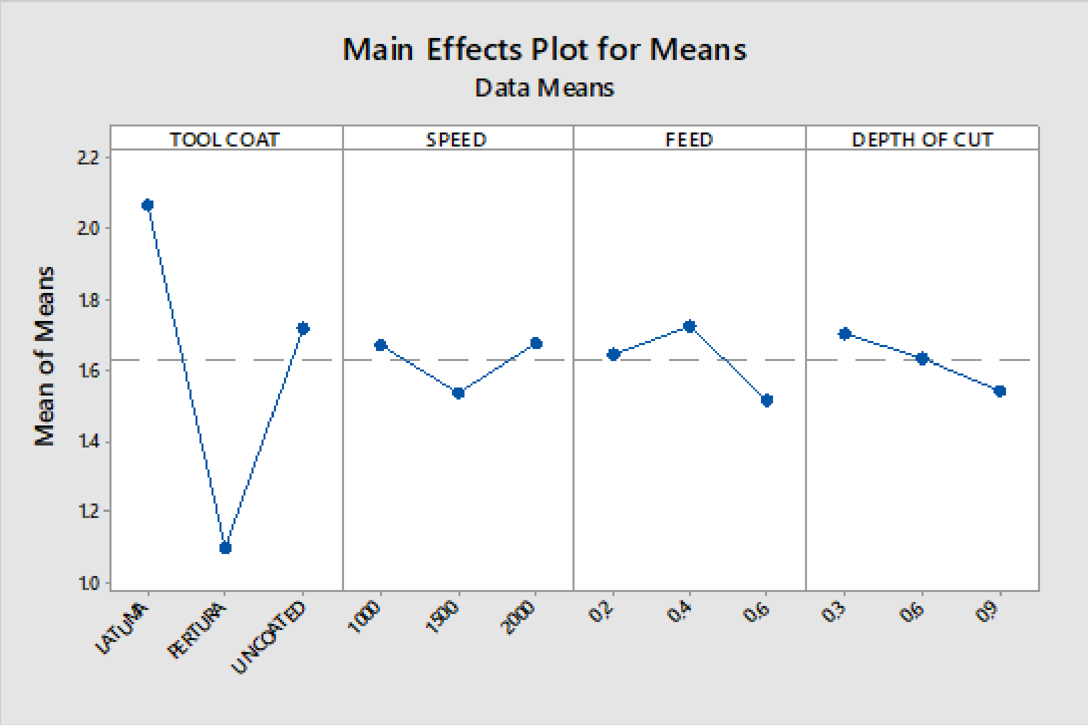
High Speed Steels are high-performance special steels offering high hardness at temperatures up to 500°C and high wear resistance, thanks to alloying elements like tungsten, molybdenum, vanadium and chromium which are able to form carbides. To improve hot hardness, cobalt may also be added. High Speed Steel is a cutting tool material used in drilling, milling, turning, threading, boring, broaching, gear cutting and many other machining operations.High Speed Steel is used for form tools, slitter knives, guillotine knives, parting tools and many other types of cutting tools.

- The recognized standard high-speed tool steel, which serves almost all applications under mild to severe metal-cutting conditions
- A smaller group of intermediate steels, which are satisfactory for limited applications under mild to moderate metal-cut- ting conditions

COMPARISION OF OPTIMIZATION RESULTS

TAGUCHI ANALYSIS:

SURFACE ROUGHNESS versus TOOL COAT, SPEED, FEED, DEPTH OF CUT



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Response Table for Signal to Noise Ratios Smaller is better:

Level	**TOOL COAT**	**SPEED**	**FEED**	**DEPTH OF CUT**
1	-6.2887	-4.1565	-4.0132	-4.1161
2	-0.7717	-3.3246	-4.4548	-4.0153
3	-4.6617	-4.2410	-3.2541	-3.5907
Delta	5.5170	0.9164	1.2007	0.5254
Rank	1	3	2	4

Response Table for mean:

Level	TOOL COAT	SPEED	FEED	DEPTH OF CUT
1	2.066	1.670	1.642	1.704
2	1.097	1.537	1.725	1.632
3	1.718	1.673	1.514	1.544
Delta	0.969	0.136	1.211	0.159
Rank	1	4	2	3

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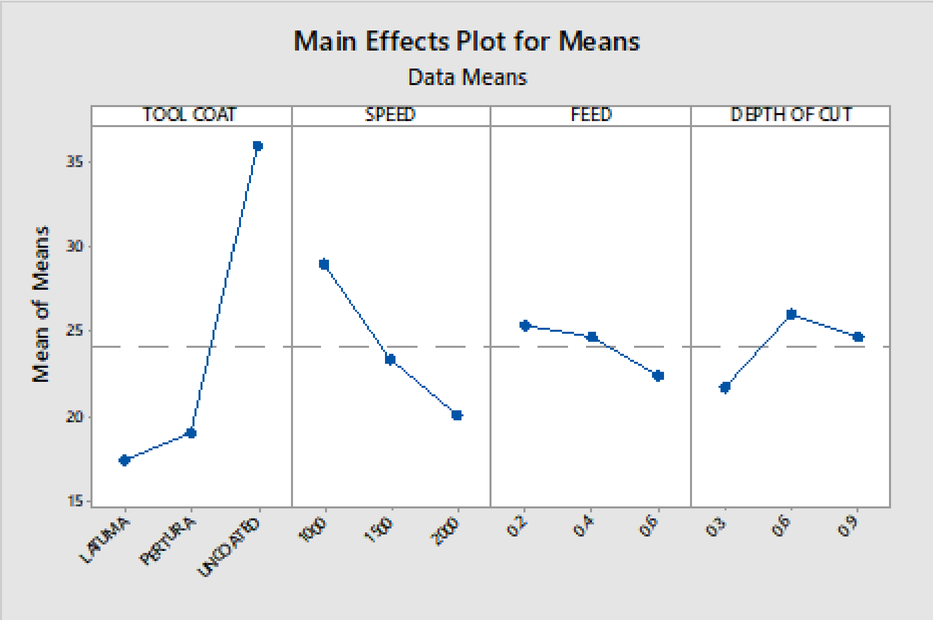
TAGUCHI ANALYSIS:

TIME versus TOOL COAT, SPEED, FEED RATE, DEPTH OF CUT



Response Table for Signal to Noise Ratios Smaller is better:

Level	TOOL COAT	SPEED	FEED	DEPTH OF CUT
1	-24.53	-28.89	-27.64	-26.30
2	-25.33	-26.62	-27.69	-27.65
3	-31.05	-25.41	-25.59	-26.97
Delta	6.52	3.48	2.10	1.34
Rank	1	2	3	4

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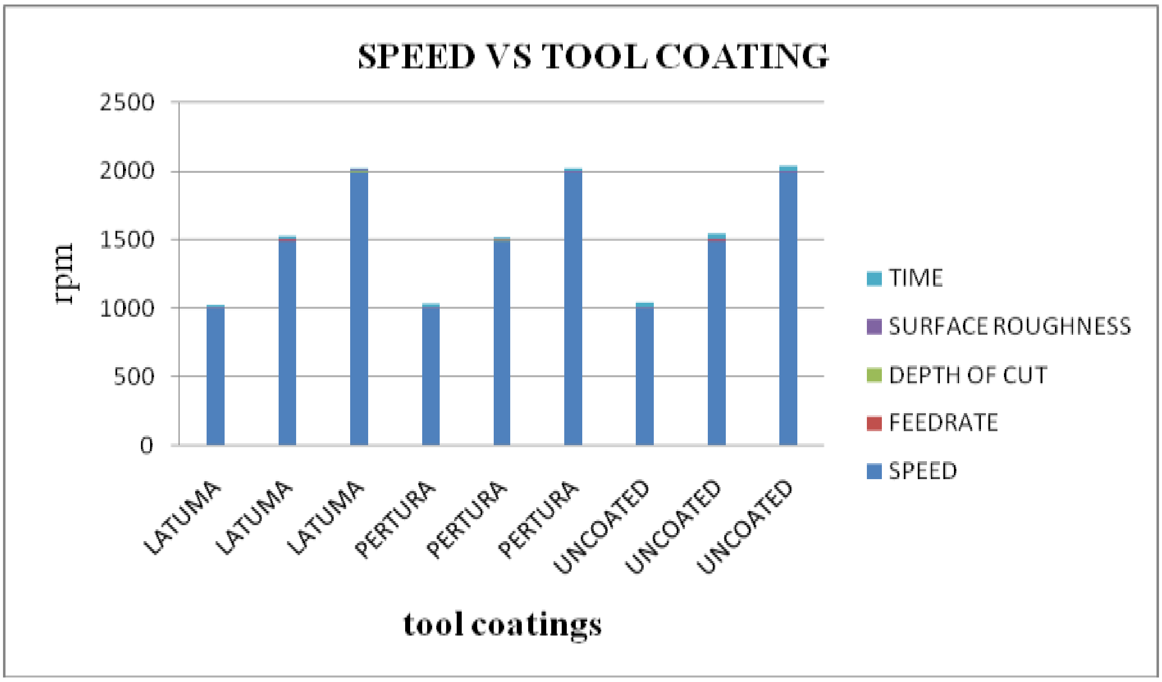
Response Table for mean:

Level	TOOL COAT	SPEED	FEED	DEPTH OF CUT
1	17.33	29.00	25.33	21.67
2	19.00	23.33	24.67	26.00
3	36.00	20.00	22.33	24.67
Delta	18.67	9.00	3.00	4.33
Rank	1	2	4	3

CNC MILLING TABULATION

TOOL COAT	SPEED (rpm)	FEED RATE (mm/rev)	DEPTH OF CUT (mm)	SURFACE ROUHGNESS (µm)	TIME (sec)
LATUMA	1000	0.2	0.3	2.201	21
LATUMA	1500	0.4	0.6	2.08	19
LATUMA	2000	0.6	0.9	1.917	12
PERTURA	1000	0.4	0.9	1.155	25
PERTURA	1500	0.6	0.3	0.971	14
PERTURA	2000	0.2	0.6	1.164	18
UNCOATED	1000	0.6	0.6	1.653	41
UNCOATED	1500	0.2	0.9	1.561	37
UNCOATED	2000	0.4	0.3	1.939	30

GRAPH



- **X-Axis :SPEED**
- **Y-Axis :TOOL COATINGS**

COATINGS

- LATUMA
- PERTURA
- UNCOATED

CONCLUSION

The following conclusion were made from the experimental project work

- Innovative tool coatings were introduced and executed in a proper manner on titanium work piece
- Thus the surface quality of the milled specimen was improved by the tool coated with latuma and pertura.
- Especially the pertura coating gave wonderful surface roughness compared with uncoated tools.
- Tool wear was reduced partially by depositing the latuma coating in the milling cutters.
- Less surface roughness value has obtained in pertura coating machining.

- Tool life and machining time saved by the usage of this kind of coated tools.
- Better machinability were obtained by titanium alloy compared with other metals.

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