# Recent Trends in Machining with Coated Tools

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**Abstract- Coated cutting tools are very useful for enhanced performance during high-speed machining of work piece such as Dry CNC turning. Modern industries use a number of coated tools for producing various highly finished products. Titanium nitride (TiN) and Titanium carbide (TiC) and Titanium oxide (TiO) has been used for the coating of cutting tools for decades. Coatings of different materials are provided on the cutting tools to increase life of tool, to enhance the surface finish of the product, and also to increase the rate of material removal. Cutting capabilities and life of cutting tools can be enhanced by 50% using hard materials (such as TiN, TiC, TiO and Al2O3) for coatings. This paper shows the study of the performance of coated tools during dry turning conditions. This paper involves the machining of hardened steel using coated cermet & carbide tools. The objective of this paper is to study the effect of different coatings on tools under various cutting conditions.**

**Keywords: Cermet, Carbide, Coatings, TiN, TiC, TiO etc.**

## I. INTRODUCTION

The modern improvements in science and technology has put remarkable stress on manufacturing industries. The manufacturing industries are trying to reduce the cutting costs, enhance the quality of the machined parts and machine more difficult materials. Machining efficiency is improved by decreasing the machining time with high speed machining. When cutting ferrous and hard to cut materials like steels, cast iron and super alloys, softening temperature and the chemical stability of the inserts material limits the speed of cutting. One important aspect that is being vigorously researched and established is the hard coating for cutting inserts. These types of hard coatings are thin films can range from single layer to number of layers and having thickness can range from few nanometers to few millimeters. Many ceramic materials such as TiN, Al2O3 and TiC retain high temperature strength, they have lower fracture toughness than that of conventional tool materials such as HSS and cemented tungsten carbides. The machining of hard and chemically reactive materials at greater speeds is enhanced by deposition of single and multi-layer coatings on conventional tool materials to combine the advantageous properties of ceramics and traditional tool materials.

## II. RECENT TRENDS IN MACHINING

W.Grzesik. et al. [1] has found that, wear of the tool flank faces are mainly concentrated on the tool corner working on double feed rate. Depending on the shape of the tool corner the surface profile produced successfully by worn tools contain many peaks with the RMS average slope values ranging from 650 to 150(CT) and 2.50 to 100 (WT).
N. RICHARD et al. [2] has found that, CBN sialon and whisper reinforced alumina appear to offer better overall performance than either conventional or mixed alumina composition at operating values for both materials are in the range 120-300 m/min, feed rates and depths of cut typically 0.25mm/rev and 2mm respectively.

T. I. EL-WARDANY et al. [3] has developed a new experimental technique that was able to measure the temperature of the cutting edge accurately without major difficulty during machining and heat generated during the cutting processes is concentrated only in the vicinity of the tool tip.

Chonghai Xua et al. [4] have developed an advanced Al2o3 based ceramic tool material ATC with the addition of free carbon with the fracture toughness of 5.89MPam1/2, the flexural strength of 782MPa and the hardness of 18.9 GPa. Experiments indicate that during machining of hardened carbon steels; adhesion wear and cracks induced by thermal shock play an important role in the tool fracture.

Zhao Jun et al. [5] has shown that the SiC-whisker-reinforced Al2O3 ceramic tool JX-1 can be used to machine nickel-based alloys. The JX-1 tool shows less superiority in machining at a very low speed than the carbide tool. At lower cutting speeds, tool life is restricted by depth-of-cut notching. With increase in cutting speed, flank wear and nose wear play important roles in determining tool life. The use of a cutting fluid can enhance the tool life as a result of the formation of a chemically adsorbed film between tool and work piece or chip.

T. Kitagawa & K. Uehara [6] have found that during high speed machining of Inconel 718 with ceramic tool, notch wear at the depth of cutline became large, while the average flank wear was very small when the cutting speed was low. The performance of SIC whisker reinforced alumina ceramic tool was good in respect of notch wear in the speed range of 100-300m/min. However when the speed exceeds 400m/min, the notch and the average flank wear of the tool became very large. It can be considered that diffusion (or reaction) between Si in the tool and Inconel 718 is the cause of the large wear. On the other hand, TIC added Alumina ceramic tool showed very small wear even at the cutting speed of 500m/min, while the fluctuation of the notch wear was very large in the speed range of 100-300m/min. However the notch wear under the low cutting speed could be suppressed by using the S type or button type tool. Furthermore, button type tool with nickel showed excellent performance for the notch wear on the end flank.

D. Dudzinski et al. [7] found that Inconel 718 is a high strength thermal resistant material alloy and difficult to cut cemented carbide tools are mostly used for cutting nickel based alloys at very low cutting speed of 20-30m/min. under dry condition cutting speed 100m/min may be achieved with coated carbide tool much higher cutting speed (from 200 to 700m/min) are attained with ceramic tool.

J. Paulo Davim et al. [8] have performed a series of experiments. The main aim of this experimental work was to establish the relationship between machinability and cutting parameters. The total wear is highly influenced by the cutting velocity (57.4%) and specific cutting pressure (13.4%) and surface roughness is influenced by feed rate (64% and 29.6%) and cutting time (32%).

Ersan Aslan A. et al. [9] found out that as cutting speed increase the tool wear decreases. To get minimum tool wear, the highest level of the cutting speed 250 m/min and depth of cut 0.25 or 0.5 mm was maintained during the experimentation. The results of the study encourage the use of Taguchi parameter design for finding optimum value cutting parameters for ceramic tools.

Ai Xing. et al. [10] have presented a model for designing functionally gradient for ceramic tool materials with symmetrical distribution, based on the analysis of stress distribution for ceramic tools in the cutting process. An Al2O3, TiC gradient tool material was synthesized by hot-pressing according to the design result.

A.K. Ghani. et al. [11] have found that the vibration during cutting at the highest speed was the lowest. This may propose that high speed machining is more stable for the tool-work machine system under consideration. With the rise of feed or depth of cut; vibration increases for the same tool wear during machining of cast iron.

Jenn-Tsong Horng et al. [12] have performed an experiment to establish a relationship between the machining parameters and the machinability performance together with tool wear and surface roughness. The examination of machining parameters using RSM technique has the benefit of investigating the effect of each machining parameters on the value of machinability evaluation.

Y.S. Liao et al. [13] have concluded that, at high cutting speed the total particles will diffuse into the binder by means of grain boundary diffusion. From experimental result it can be seen that the diffusion distance at high temp is around 101-103um and for bulk diffusion is around 100-101um.

Abhay Bhatt et al. [14] have used three tools during experimentation. From experiment it is found that CVO coating exhibits the highest wear resistance at high speed of 100m/min and low feed. Uncoated tool performed best at cutting speed 50m/min and tool with single layer PVD coating performed good than other tools at cutting speed of 75m/min.

Davi Nevesa et.al. [15] have concluded that, the adhesion between TIALN PVD coating and the substrate of the laser textured tool was better than standard tools. Laser texturing produced better coating substrate adhesion in air than water. Laser textured increases the life of the tool. For laser textured tools flank wear and for standard tools notch wear was responsible for ending tool life.

Gérard Poulachon A et al. [16] have done an experimental study which shows the influence of the steel microstructure on tool wear in CBN tool. For steel the increasing cutting speed has greater impact on tool wear. The lesser effect on steel containing carbides could be explained by the fact that the hardness of these carbides is not affected by the cutting temperature.
L.J. Yang. et al. [17] found that wear coefficient of tungsten carbide with an angular setting with the counter disk increases with sliding distance initially, and remains constant after that and with full contact decrease with sliding distance initially and reach more study value after the initial period. Experiment explain the discrepancy of the wear coefficient value obtained by the turning operation.
A. Devilleza .et al. [18] have examined different cutting conditions in order to find the optimal ones. Finally the best coated tool was used for a bar turning operations and a suitable life time was obtained.
R.F. A .et al. [19] studied that the highest wear rate during coated tool was obtained by the TILN coated carbide tool and it has been occurred due to the high amount of aluminum in the coating material.
Kumar et al [20] observed that coated tools give better results as compared to uncoated tools in turning. The uncoated tools has been successfully employed for machining of soft ductile material like Al and for the soft and abrasive materials like Al-Si alloy. The surface finish obtained under dry machining has been found to be acceptable. However, the surface finish produced for Al-Si alloy is not acceptable. Hence, this better surface can be achieved by use of coated or multilayer coated on cermet tools having coatings of Ti (C, N, O).

## III. CONCLUSION

From the study we can conclude that flank faces are mainly concentrated on the tool corner working on double feed rate and heat generated during the cutting operation is concentrated only in the vicinity of the tool tip. It has been also found that the advanced Al2o3 based ceramic tool material ATC with the addition of free carbon can reduce the adhesion wear and cracks induced by thermal shock which play an important role in the tool fracture. It has been also found that the ceramic tool can be used to machine nickel-based alloys and it shows less superiority in machining at a very low speed than the carbide tool. Also with the rise of feed or depth of cut; vibration increases for the same tool wear during machining of cast iron.

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