Indian J.Sci.Res. 17(2): 141-144, 2017
ISSN: 0976-2876 (Print)
ISSN: 2250-0138(Online)

# IMPROVEMENT OF TOOL LIFE AND SURFACEROUGHNESS OF TURNING INSERTS OF HSS USING LATUMA COATING

[1]M.Saravanan, [2]S.Gowtham Sanjai, [3]A.M. Vinoth kumar
[1]Department of Mechanical Engineering,AarupadaiVeedu Institute of Technology, Vinayaka Missions University, Tamil Nadu
[2]Department of Mechanical Engineering, Christ University, Mysore Road, Kumbalgodu, Kanmanike, Bengaluru, Karnataka
[3]Department of Mechanical Engineering, Aurora's Scientific,Technological & Research Academy Hyderabad, Telangana

***Abstract***-The effect of material coating and process has long been an issue in understanding mechanic of machining. Tool coating material has important effect on chip formation, heat generation, tool wear, surface finish and surface integrity during machining. So it has been well well-known that advanced surface coatings on cutting tools improve wear resistance by changing the contact conditions between chip and tool interface further resulting to extended tool life, less cutting time and better machining quality.Success in machining can be achieved by the proper selection of cutting tool. The mode of tool failure is very damaging not only for the tool but also for the job. Hence, this kind of tool failure needs to be prevented by using suitable tool materials and geometry depending upon the work material and cutting condition. Significant cost reductions and surface quality improvements are obtained by high-speed machining of aluminum alloys, carbon steels, and other conventional materials. However, there are some materials, especially challenging-to machine alloys such as hardened steels used for dies and moulds, chrome-cobalt alloys used for prostheses, and nickel-base alloys as well as high alloyed steels used in gas turbines. In these cases, high-speed cutting technologies face serious difficulties.

## I. Introduction

The aim of the project is HIPERCUT (New Coating for High Performance Cutting Tools), which is used for high-speed machining of the above-mentioned work piece materials. Presently available TiN coatings as reference, the project visualizes new Ti-based coating, AlTiN coatings. In this study, Aluminum Titanium Nitride (AlTiN) film was deposited on the high speed steel cemented turning insert substrate adopting the cathodic arc deposition and PVD process respectively. The AlTiN film was characterized with Scanning Electron Microscope (SEM).To evaluate their cutting performance, a set of experiments with constant cutting speed, depth of cut and feed rate were performed on a CNC lathe without coolant (Dry Machining) using the uncoated HSS, AlTiN coated inserts, with hot rolled low carbon steel as the work piece. Surface roughness of the work piece was measured by contact type surface roughness tester. Flank wear and aluminum adhesion were measured by SEM. From the result, it was found that AlTiN coated insert performs better than the non-coated HSS tool in terms of tool life and surface finish of component.

**Physical Vapor Deposition-** Physical Vapor Deposition (PVD) is a process to produce a metal vapor that can be deposited on electrically conductive materials as a thin highly adhered pure metal or alloy coating. The process is carried out in a vacuum chamber at high vacuum (10-6 torr) using a cathodic arc source. Single or multi-layer coatings can be applied during the same process cycle. Additionally the metal vapor can be reacted with various gases to deposit Oxides, Nitrides, Carbides or Carbonitrides.

**Scanning Electron Microscope-** A scanning electron microscope (SEM) is a type of electron microscope that images a sample by scanning it with a beam of electrons in a raster scan pattern. The photographic view of SEM is shown if Figure 1.10. The electrons interact with the atoms that make up the sample producing signals that contain information about the sample's surface topography, composition, and other properties such as electrical conductivity.

## II. Experimental Set Up

**CNC Turning Centre -** Computer Numerical Controlled (CNC) lathes are rapidly replacing the older production lathes due to their ease of setting, operation, repeatability and accuracy. They are designed to use modern HSS and carbide tooling and fully use modern processes. The part may be designed and the tool paths programmed by the CAD/CAM process or manually by the programmer.The machine is controlled electronically via a computer menu style interface; the program may be modified and displayed at the machine.

**Machining parameters-**The cutting parameters selected for machining Hot rolled - Low Carbon Steel are given below. The parameters are kept constant throughout the machining processes.

Feed rate: 0.2mm/rev, Depth of cut:0.5mm, Cutting speed:250 rev/min, Machining time:5min

[1]Corresponding Author

**Work piece Material-High Speed Tool Steel:** The need fortool materials whichcould withstand increased cutting speeds and temperatures, led to the development of high speed tool steels (HSS). The major difference between high speed tool steel and plain high carbon steel is the addition of alloying elements to harden and strengthen the steel and make it more resistant to heat (hot hardness).

**Cutting Tool Coating Material:** The Aluminum Chromium Nitride (AlTiN) is deposited on the HSS specimens respectively adopting the physical vapor deposition (PVD) technique. The deposition of suitable materials prior to AlTiN by Physical Vapor Deposition (PVD) onto HSS should cause an improvement in adhesion due to the suppression of binder interactions with the gas phase.

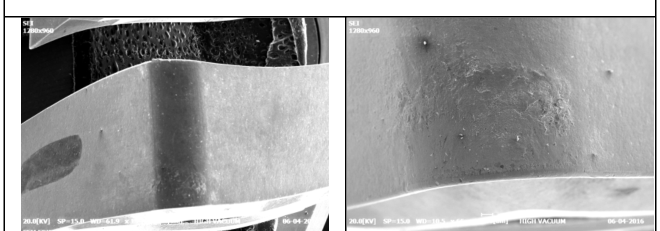
**AlTiN coating:** The optimized relationship of hardness and residual compressive stress of the Aluminum Titanium Nitride (AlTiN) coating increases the stability of the cutting edges of machining tools.Its outstanding thermal and chemical resistance permits dry cutting and improvements in performance of highly stressed components. The high hardness of the coating gives outstanding protection against abrasive wear and erosion. The properties of AlTiN coating is given in the below table

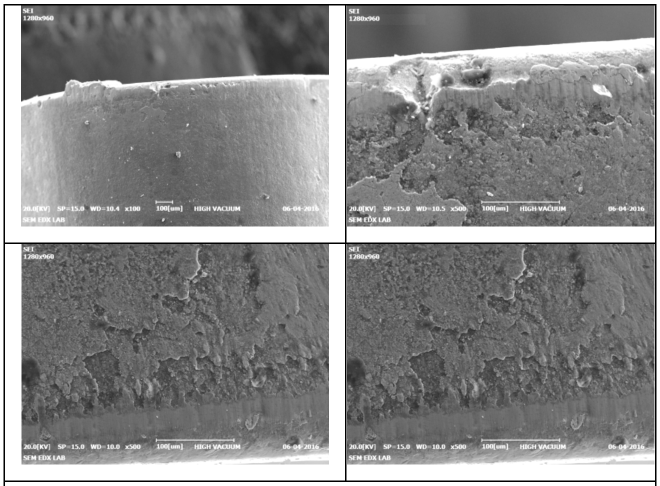
| Sl.No. | Parameter | Value / Name |
|---|---|---|
| 1 | Coating Material | AlTin |
| 2 | Micro Hardness(HV) | 32 Gpa |
| 3 | Coating thickness | 4μm |
| 4 | Max.Service Temperature | 898˚C |
| 5 | Coating Technique | PVD |

## III.Result And Discussion

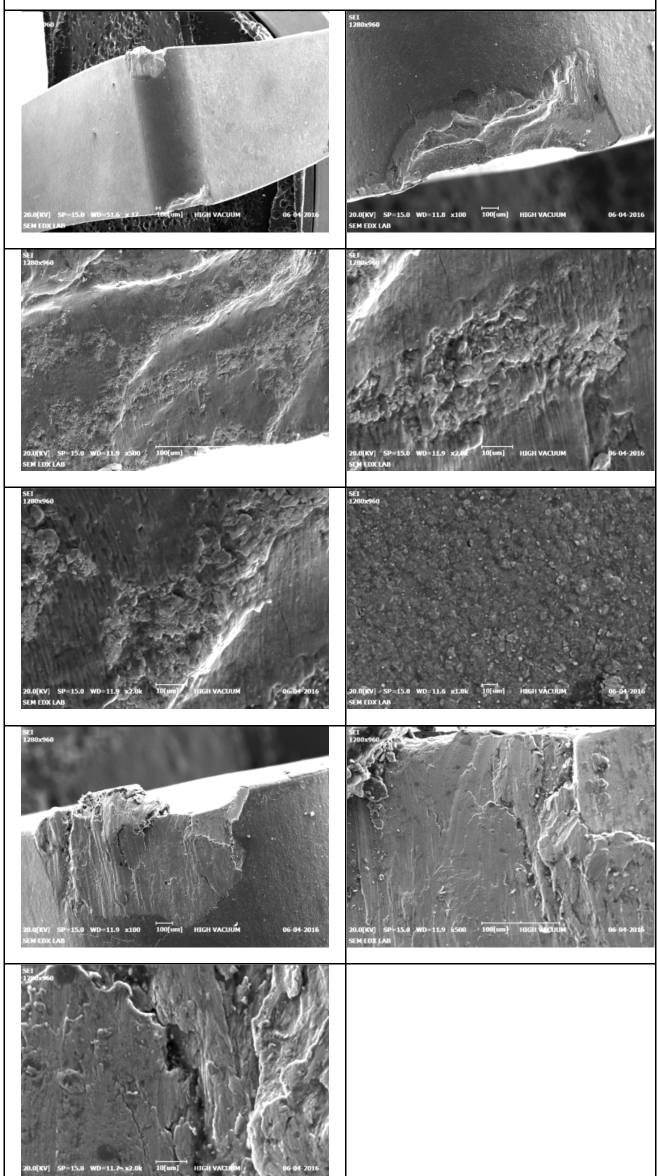
Tribological And Microstructure Behavior Of Latuma(Altin)Coating

**SEM IMAGE(WITH COATED INSERT)**



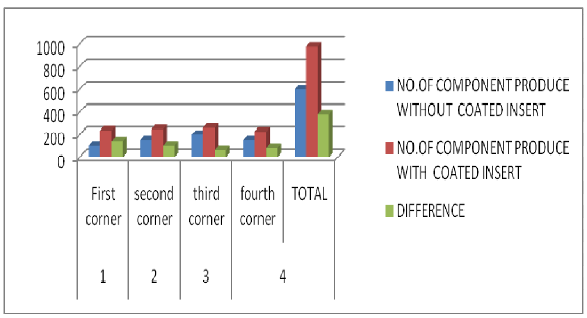


**SEM IMAGE (WITHOUT COATED INSERT)**



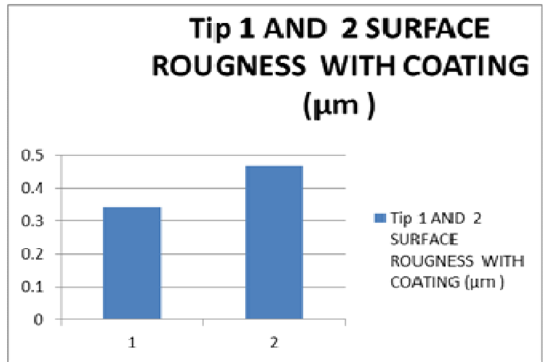
**Based On Tool Life**

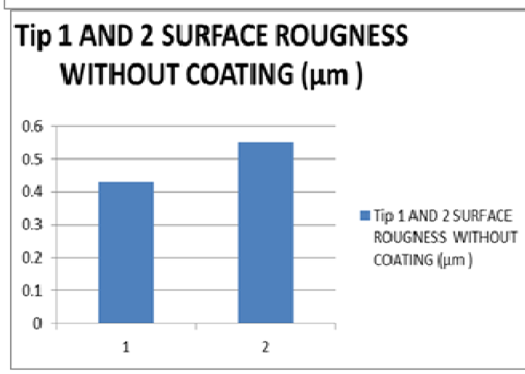
| Sl.No. | Position | No.of component produced without coated insert | No.of component produced with Latuma coated insert | Additional Components Produced after coating |
|---|---|---|---|---|
| 1 | First corner | 100 | 238 | 138 |
| 2 | Second corner | 150 | 249 | 99 |
| 3 | Third corner | 200 | 261 | 61 |
| 4 | Fourth corner | 149 | 228 | 79 |
| | **TOTAL** | **599** | **976** | **377** |



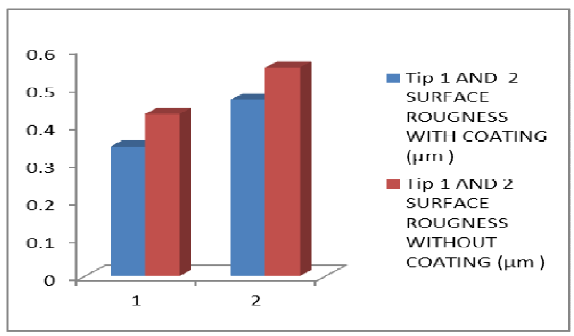

**Based on Surface Roughness**

| Sl.No | INSERT | SURFACE ROUGNESS ( Ra ) values | |
|---|---|---|---|
| 1 | Tip 1 AND 2 SURFACE ROUGNESS WITH LATUMA COATING (µm ) | 0.343 | 0.467 |
| 2 | Tip 1 AND 2 SURFACE ROUGNESS WITHOUT COATING (µm ) | 0.429 | 0.552 |




Combination Of ( Ra) Value With And Without Coating




From the analysis of our project work we are going to conclude that if we use a insert having Latuma (AlTiN) coating we can clearly see improvement of 62.9% i.e approximately 63% of more component can be produce by using coated insert and the coating cost compare to the insert cost is very low. The surface roughness of the coated insert i.e. 0.343 Ra value compare to without coated insert i.e. .429 is very considerable. Here from the surface roughness value we can conclude that if our surface roughness value is less the heat produce is also less hence the damage from heat can be prevented

## IV. Conclusion

Aluminum Titanium Nitride (AlTiN) was deposited on the cobalt cemented high speed steel turning insert substrate adopting the PVD process. The coating was performed with a thickness of approximately 2 microns. To evaluate their cutting performance, a set of experiments with constant cutting parameters were performed on a CNC lathe without coolant (Dry Machining) using the uncoated HSS , AlTiN coated inserts, with heat treated Hot rolled - Low Carbon steel as the work piece. The cutting parameters selected were cutting speed of 250 m/min, depth of cut of 1mm and feed rate of 0.2 mm/rev. The machining was carried out for 3 hours. The AlTiN films were characterized with Scanning Electron Microscope (SEM), F Rockwell indentation test, srface roughness test. The following are the conclusion that we have inferred.

- The insert wear was measured for after each machining. Surface roughness of the work piece was measured by contact type surface roughness tester.
- Another set of experiment was carried out to analyze the flank and crater wear on the insert for 30 minutes. Flank wear was analyzed by SEM.
- It was found that AlTiN coated insert gives better surface finish when compared to uncoated inserts.
- No prominent wear was been visible on the inserts after 3 hours of machining but chip off of the insert appeared for uncoated inserts.
- From SEM analysis it is evident that the wear rate of the tool is less when compared to uncoated tools.
- This coating presented low friction coefficients and wear re tested by pin disk**.**
- It has wide potential tribological applications under sliding wear condition.
- The AlTiN coating deposited by the PVD process showed most of the applications for manufacture used in this process. The structural analysis shows that the heat treatment of AlTiN coating allows recystallization and crystal growth, enhancing its wear behavior.
- This coating can be used with acceptable levels of productivity in the drilling operation

## References

[1]. Schramm B.C. , H. Scheerer, H. Hoche, E. Broszeit, E. Abele, C. Berger "Tribological properties and dry machining characteristics of PVD-Coated carbide inserts" (2004).

[2]. Ajay P. Malshe ,Wenping Jiang "Cubic Boron Nitride (cBN) based nanocomposite coatings on cutting inserts with chip breakers for hard turning applications" (2005) .

[3]. Dr. Vikas Chawla "High Temperature Corrosion and Erosion: Nanostructured and Conventional Coatings" (2008).

[4]. Chattopadhyay A.K., P. Roy, A. Ghosh, S.K. Sarangi " Wettability and machinability study of pure aluminium towards uncoated and coated carbide cutting tool inserts" (2009).

[5]. Christian Stein, Martin Keunecke, Klaus Bewilogua , Thomas Chudoba , Werner Kölker , Henk van den Berg "Cubic boron nitride based coating systems with different interlayers for cutting inserts" (2011)

[6]. ThiHuyen Tram Pham "Structure and Mechanical Properties of Thin Films AlTiN" (2011)