Available online at www.ijapie.org

International Journal of Advanced Production and Industrial Engineering

IJAPIE-SI-MM 513 (2017) 85–87

Special Issue on

MATERIALS & MANUFACTURING

Different Tool coatings: An Overview

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Abstract : *In Surface coated tools plays an important role in metal cutting industry and forming industry. The basic requirement of good finish is achieved due to tool coatings. Tool wear are topic of research interest. Various techniques of tool coatings failure is being studied with advanced experimental and analysis techniques as FEM(Finite Element Modelling) etc. The strength of coating depend on the material used as coating, process employed and thickness of coating. A good quality coating as Ti, W based systems can ensure enhanced tool life. The process of coating deposition can be classified into PVD and CVD based systems. Physical Vapour Deposition involves low temperatures of order of 300°C to 500°C and Chemical Vapour Deposition involves high temperatures in range 800°C-1100°C. PVD is far more superior technology than CVD since the low temperatures encountered. Many polymers can easily deposited by this technique. CVD coatings thicker than PVD coatings, from 10μm to 1mm. In CVD quality of coating is dependant upon materials to be coated, the deposition temperature, the pressure within the vessel, the type and flow rate of the carrier gas.*

Keywords: *PVD, CVD , coating, Tool failure, Temperature, Techniques*

1. Introduction

The metal cutting and sheet metal forming industry are advancing rapidly due to advance technologies in Machinery(Tool and Dies) and cutting tool. Researchers are experimenting with wide ranges of coating materials as polymers to one point to Metal-Polymer matrix to other point. However the result is wide variety of coatings available to choose from. Industries as Nuclear power plants, Aero-space units, Precision industries as Surgical instruments are possible due to rapid and advancement in tool coating technology.[1-2]

Tool coating enables one or multilayer refractory compounds to be deposited on tool material. Today concept of cutting fluid less machining is finding usage in accordance with pollution norms. This is also term as Green machining and Dry machining. Flexibility and positive ecological effects are other advantages of dry hard machining [3]

Major reason of cutting tool edge failure is thermal, chemical and mechanical loading. Cutting tool wear plays a major role finish turning due to its effects on surface integrity and dimensional accuracy. The types of wear patterns are flank wear and crater wear [4]. Abrasive wear has been cited as a main wear mechanism in turning [5].

Various types of tool coatings has been developed over the years like Ti based coatings as TiN, TiAlN, TiN+TiAlN,TiCN etc. Al_2O_3 as ceramic form has been used in machining; but its brittleness is a limiting factor to its more widespread use as a cutting tool material. The TiC/Al_2O_3 coated carbide insert was first invented in 1975. TiCN and Al_2O_3 sublayers have complementary effects. The intermediate Al_2O_3 layer could improve the heat flow into the chip compared with other types of coating. CVD Al_2O_3 hard coatings have also shown the best results in terms of chemical stability in machining ferrous materials [6-7].

The uses of commercially pure titanium are limited to areas where moderate strength, high corrosion resistance, and good weldability are re**q**uired [8]. As per statistics available, 40% of all cutting tools used in the industry were reported to be coated tools, which are used for 80% of all machining jobs [9]. Straight grade carbides with 6% cobalt content is optimal for machining Ti6Al4V alloy [10]. TiN-coated cermet, TiC-coated carbide, ceramic aluminum oxide, and CBN tools were not good for machining titanium alloys.

As the first generation of coating ,TiN coatings display many advantages(such as low COF, good friction resistance, and high toughness and hardness) [11] . Natural diamond performed better than PCD .While PCD and showed similar performance [12]. PCD tools have the highest tool life followed by CBN with multi-coated tools showing highest tool wear[13]. multi-coated inserts as TiN/TiCN/TiN had shown better tool life than TiN-coated inserts, at lower feeds [14].

2. TOOL COATING CHARACTERISATION

The most important characteristics which specify the coating:

2.1.Thickness:

In most of coatings the thickness is between 0.2 µm -2 µm. It can be measured with help of CaloTester .

In Calo Tester a hardened steel sphere with a known and fixed diameter rolls on the surface for some seconds depending on coating thickness (for example 20 seconds for thickness in between 0.1 µm and 5 µm). The pressure on the substrate generates artificial superficial craters. Then, through optical microscope it is possible to measure crater depth and diameters.

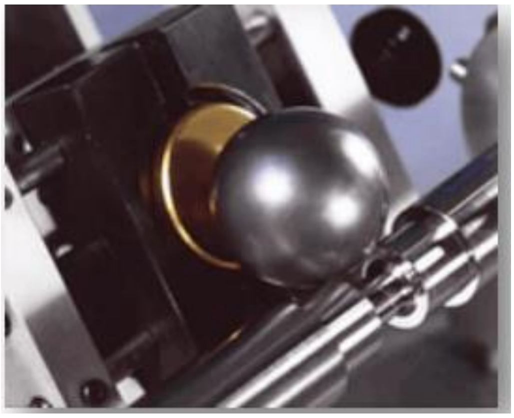

Figure 1: Calo Tester

2.2. Wear Coefficient:

A low wear coefficient is necessary in various applications as molding, forming, tools, automotive etc. Wear coefficient quantifies substrate wear caused by mechanical brushing. “Tribometer” is used to check Wear. Samples roll against a metal tester sphere. It is important to calibrate right forces, rotation speed and sphere diameter. Instrument measure normal and lateral forces in order to calculate wear coefficient.

2.3. Roughness:

It measures surface quality and surface texture.

2.4.Adherence:

It is important to achieve high adhesion to the substrate so as to get thick coating system.

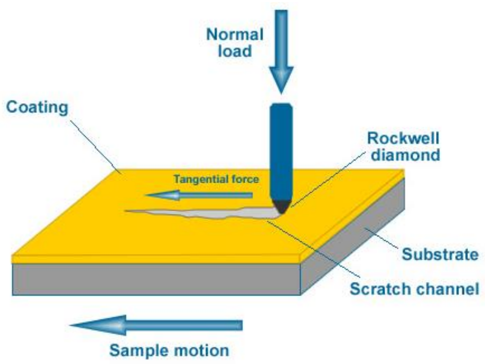

Figure 2: Rockwell Tester

A resistant Rockwell Tester is used.

2.5. Hardness:

It is a parameter to define plastic deformation. Important thin film characteristics are surface hardness and elastic module. A lab tester, called “Nano indentation tester” is used to perform test. During test, a normal force is applied with different intensity. Then the relation between forces and tester depth defines mechanical characteristics, like hardness and elastic module.

2.6. Corrosion Resistance:

Corrosion is the cause of performances reduction during product life. The corrosion behaviour of different coatings are based on climate and ambient conditions of use. Oxidation, reduction, spots, blisters etc fall into this category.

3. RESULTS AND CONCLUSIONS

Various coatings are available in market today. But selection of coating remains a tedious task as cost and other considerations have to be made judiciously.

However on basis of various selection parameters as metal to be machined, cutting conditions, type of finish required, type of machining required, area of application etc will determine type of coating to be selected. For example

1. Titanium-based alloys are classified as difficult to machine materials as they cause high tool wear.

2. Multi-layer thermal barrier coatings with improved surface properties, in terms of reactivity with titanium that could be used effectively in the industry for machining titanium-based alloys[15].

3. The Al_2O_3 + TiO_2, in which theTiO_2 plays a lubricating effect and the Al_2O_3 provides wear resistance and oxidation resistance at high temperatures.[16]

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