IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

COMPARISION OF MACHINING PARAMETERS ON HSS CUTTING TOOL COATED BY MULTI-WALLED CARBON NANO TUBES USING ELECTROPLATING DEPOSITION

P Srinivas Reddy*, Dr T Victor Babu, S Santhosh Kumar

[1]Assistant Professor, Lendi Institute of Engineering and Technology, Vizianagaram, Andhra Pradesh, India

[2]Professor & Principal, Sri Sai Educational Society Group of Institutions, Kodad, Telangana, India

[3] Assistant Professor, Lendi Institute of Engineering And Technology, Vizianagaram, Andhra Pradesh, India

DOI: 10.5281/zenodo.557139

ABSTRACT

The present work aims on study of nano coatings and its analysis on HSS (tool bit) by using electroplating deposition technique. In this method Multi wall Carbon nano tube (MWCNT) nano particulates are deposited on High Speed Steel tool bit to find out the enhancement and effectiveness of the coatings. Uncoated and coated tool bits are compared by considering various machining parameters. Various other operations such as surface roughness and tool wear were performed during the process.

KEYWORDS: HSS - High Speed Steel, MWCNT - Multi Wall Carbon Nano Tube, EPDT - Electro Plating Deposition Technique.

INTRODUCTION

The manufacturing industry is constantly striving to decrease its cutting costs and increase the quality of the machined parts as the demand for high tolerance manufactured goods is rapidly increasing. The increasing need to boost productivity, to machine more difficult materials and to improve quality in high volume by the manufacturing industry has been the driving force behind the development of cutting tool materials. Numerous cutting tools have been developed continuously since the first cutting tool material suitable for use in metal cutting, carbon steel, was developed a century ago.

1.1 EFFECT OF CUTTING SPEED ON MACHINING:

High speed steels are the most popular and most common high production tool materials available today. The productivity enhancement of manufacturing processes is the acceleration of improved cutting tools with respect to the achievement of a superior tribological attainment and wear-resistance. This resulted in developing hard coating for cutting tools; these hard coatings are thin films of one layer to hundreds of layers. The majority of carbide cutting tools in use today employ chemical vapour deposition (CVD) or physical vapour deposition (PVD) hard coatings. The high hardness, wear resistance and chemical stability of these coatings offer proven benefits in terms of tool life and machining performance.

The reason PVD is becoming increasingly favorable over CVD is the fact that the coating process occurs under much lower temperature. The use of coolant to increase tool life has been an issue with different views. The inherent brittleness of HSS makes them susceptible to severe damage by cracking if sudden loads of thermal gradients are applied to their edge. High speed machining of hardened steel has the potential of giving sufficiently high quality of the machined surface to make finishing operations such as grinding and turning. And also to improve the machining parameters like MRR, surface roughness, Tool wear and Tool life.

1.2 ELECTROPLATING:

Electroplating is the application of a metal coating to a metallic or other conducting surface by an electrochemical process. The article to be plated (the work) is made the cathode (negative electrode) of an

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

electrolysis cell through which a direct electric current is passed. The article is immersed in an aqueous solution (the bath) containing the required metal in an oxidized form, either as an equated cation or as a complex ion. The anode is usually a bar of the metal being plated.

1.3 CARBON NANOTUBES (CNT):
A carbon atom can form various types of allotropes. In 3D structures, diamond and graphite are the allotropes of carbon. Carbon also forms low-dimensional (2D,1D or 0D) allotropes collectively known as carbon nano materials . Carbon nano tubes are unique tubular structures (1D) of nano diameter and large length/diameter ratio. They are allotropes of carbon with a cylindrical nanostructure.

Types of CNT's:
Carbon nano tubes are mainly categorized as two types they are

a) Single walled carbon nano tubes (SWCNT).
b) Multi walled carbon nano tubes (MWCNT).

1.4 Properties of carbon nano tubes:
CNTs reportedly have extremely high surface areas, large aspect ratios, and remarkably high mechanical strength. The tensile strength of CNTs is 100 times greater than that of steel, and the electrical and thermal conductivities approach those of copper. CNTs are also good incorporating agents due to their unique electrical, mechanical and thermal properties.
All content should be written in English and should be in 1 column.

MATERIALS AND METHODS

2.1 Material Procurement:
2.1.1 Multi-Wall Carbon Nano Tubes:
MWCNT is the ultra pure multi-wall carbon nano tubes produced by catalytic carbon vapour deposition (CCVD) process. CNT's are allotropes of carbon with molecular structures that are tubular in shape, having diameters on the order of a few nanometers and the following **"Multi walled carbon nano tubes"** powder is procured from the **"AD-NANO TECHNOLOGIES PRIVATE LIMITED"**, Karnataka.

Table -1: Technical parameters of MWCNT

Carbon Nano Tube	Description
Type	Multi-wall Carbon Nano Tube
Colour	Black Powder
Purity	>99 %
Average Diameter	10-15 nm
Average Length	1-5 µm
Amorphous Carbon	<1 %
Surface Area	370 m^2/g

2.1.2 GEOMETRY OF SINGLE-POINT CUTTING TOOL:
The single-point cutting tool mainly consist of tool shank and cutting part called point. The point of cutting tool is bounded by cutting face, end flank, side flank and base. The chip slide along the face.

The side cutting edge is formed by intersecting of face and side flank. The end cutting edge is formed by intersection of end flank and base. The point which the intersection of end cutting edge and side cutting edge is called nose.
Tool signature of High speed steel tool: 8-14-6-6-20-15-0.8.

2.1.3 GRINDING PROCESS OF HSS CUTTING TOOL:
A 12*6 sized HSS tool bits are being purchased at SWASTIK ENTERPRISES and the tool bits are grinded according to the ASTM standards. The tool bit angles are generated on the grinding machine and the following angles are measured using bevel gauge protractor.

Figure 2.1.3 (a): HSS tool bit nomenclature shaped on grinding machine

Figure 2.1.3 (b) : Measurement of tool bit angle using bevel gauge protractor.

2.1.4 THIN FILM COATINGS AND ITS IMPORTANCE

A thin film is a layer of material ranging from fractions of a nanometer (monolayer) to several micrometers in thickness. The controlled synthesis of materials as thin films (a process referred to as deposition) is a fundamental step in many applications. A familiar example is the household mirror, which typically has a thin metal coating on the back of a sheet of glass to form a reflective interface. The process of silvering was once commonly used to produce mirrors, while more recently the metal layer is deposited using techniques such as sputtering.

Thin Film Coatings are Sub-classified in to two types:

a) Chemical Vapour Deposition
b) Physical Vapour Deposition

Electroplating deposition is one form of physical vapour deposition Technique. Electroplating is the process of plating one metal onto another by hydrolysis, most commonly for decorative purposes or to prevent corrosion of a metal. There are also specific types of electroplating such as copper plating, silver plating, and chromium plating. Electroplating allows manufacturers to use inexpensive metals such as steel or zinc for the majority of the product and then apply different metals on the outside to account for appearance, protection, and other properties desired for the product. The surface can be a metal or even plastic.

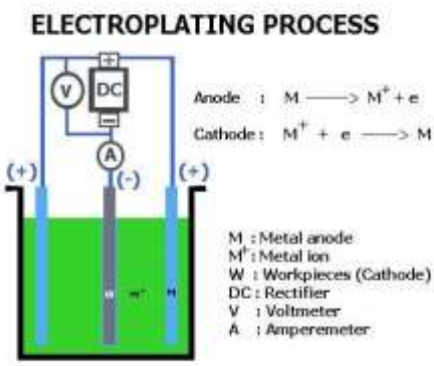

Figure 2.1.4: Electroplating principle diagram

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

EXPERIMENTATION

3.1 Electroplating deposition is a technique through which the tool bit is coated using Carbon Nano Tubes, the following is the method to coat tool bit using PVD. electroplating deposition (EPD). EPD is commonly employed in processing of ceramics, coatings and composite materials. It is a high-level efficient process for production of films or coatings from colloidal suspensions: electroplating deposited materials exhibit good microstructure homogeneity and high packing density.

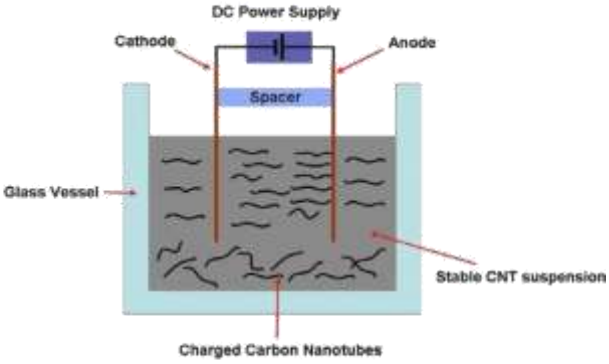

Figure 3.1: Schematic diagram of the electroplating deposition of CNTs on the cathode of an EPD cell with planar electrodes.

WORKING PRINCIPLE:

The technique allows the application of coatings, thin and thick films, the shaping of bulk objects, and the infiltration of porous substrates, fibrous bodies and textile structures with metallic, polymeric or ceramic particle. The interest in the EPD technique is driven not only by its applicability to a great variety of materials (and combinations) but also by its simplicity; EPD is a cost effective method usually requiring simple equipment as well as being affordable.

EPD is achieved via the motion of charged particles, dispersed in a suitable solvent, towards an electrode under an applied electric field. Deposition on the electrode occurs via particle coagulation. Electroplating motion of charged particles during EPD results in the accumulation of particles and the formation of a homogeneous and rigid deposit at the relevant (deposition) electrode. EPD is essentially a two step process. In the first step the particles are suspended in a liquid are forced to move towards an electrode by applying an electric field(electroplating). In the second step, the particles collect at the electrode and form a coherent deposit (deposition). Deposition occurs only on con- ducting surfaces; however non-conductive.

Table 2: List of materials required for electroplating

Materials Required	Quantity
Battery Power Supply	1
Distilled Water	3 Litres
Tissue Papers	1 Packet
Emery Papers	1/0,2/0,3/0,4/0,300/0, 400/0,600/0 (3 Sets)
CTAB	200 ml
Ethanol	500 ml
Acetone	500 ml
Spatula	2
Diamond Paste	2 Tubes

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

3.2 Electroplating Deposition Procedure:

The procedure starts from the tool bit i.e. the emery papers are being used and polished with the series mentioned in the tabular form (1/0,2/0,3/0,4/0,300/0,400/0,600/0) And after polishing the diamond paste tubes are applied on the surface of the tool bits.As reported in the literature, several types of solvents have been used to prepare CNT suspensions for EPD, including distilled water, mixtures of acetone and ethanol, and pure organic solvents such as ethanol, isopropyl alcohol (IPA), n-pentanol, ethyl alcohol, tetrahydrofuran (THF), dimethylformamide (DMF) and deionised water with pyrrole. A summary of the suspensions prepared for EPD experiments, according to the literature, is given in Table 1. As discussed previously, dispersing CNTs homogeneously in a suitable solvent is a necessary step for controlled manipulation of CNTs. Purified/functionalized CNTs can be dispersed, to some extent, in all of the solvents mentioned above

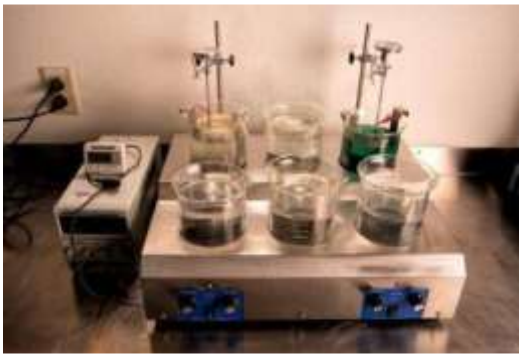

Figure 3.2.1: Electro plating equipment used for thin film coating.

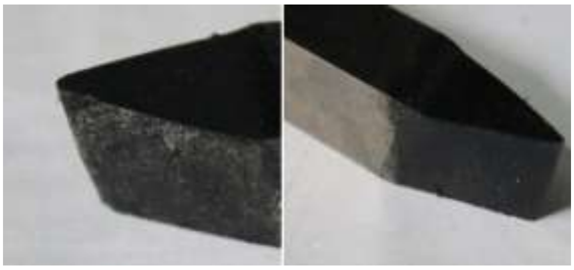

Figure 3.2.2: MWCNT Coated HSS tool bit after Electroplating deposition

3.3 Machining Parameters:

The machining parameters such as speed, feed and depth of cut are observed by using an all geared lathe, which is mostly preferred for turning operations. There were three process parameters with the four levels to investigate the response variables. The below table shows the process parameters along with the levels of process parameters selected based on availability of lathe specifications this range is quite common during conventional machining.

Table 3: Process parameters and its levels

Process Parameters	Level 1	Level 2	Level 3	Level 4	Level 5
Depth of Cut (mm)	0.5	0.7	0.9	1.0	1.5
Feed (mm/rev)	0.4	0.5	0.7	0.8	1.0
Speed	70	115	190	300	460

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

(RPM)					

3.4 Response Variables:
There are four response variables which were subjected to investigate during the turning test at various levels of process parameters. Response variables are tool wear, surface roughness and metal removal rate and tool life.

Figure 3.4: Surface Roughness Measurement for EN24 Mild Steel Specimen Using Talysurf

Surface roughness measurement on EN 24 Mild steel Specimen is tested by using both coated and uncoated tool bits and the following Ra, Rq, Rz values are determined.

RESULTS AND DISCUSSION

4.1 Metal Removal Rate (M.R.R):
It has been observed that material removal rate (MRR) increases with increasing the speed. This is because time is an important factor for MRR, for the same time at maximum speed number of turns increased. MRR increases with increasing the feed rate, but initially at lower feed rate MRR has been found to be increasing slowly. Similar pattern has been observed in case of depth of cut. Increasing the depth of cut the MRR also increased because the maximum thickness of chip may be removed.

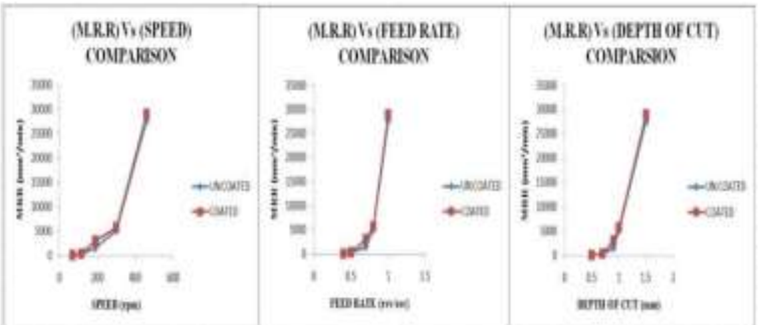

Figure 4.1: Comparison graphs for MRR Vs Machining parameters

Above plot is for metal removal rate Vs speed, feed rate, depth of cut. The results show that coated tool bit and compared with uncoated tool bit is exhibiting good properties. When compared with the former. Increases in metal removal rate are observed in coated tool bit.

4.2 Surface Roughness:
It has been observed that surface roughness decreases with increase in speed. This is due to fact that at higher cutting speeds, cutting forces and tendency towards built-up edge formation weakens due to increase in temperature and consequent decrease of frictional stress at the rake. The surface roughness increases with increase in the feed rate. The surface roughness has been found to be increased with increasing the depth of cut. This is because, as the depth of cut is increased, cutting forces increases. Hence, the waviness of peaks increases leading to increase in surface roughness.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

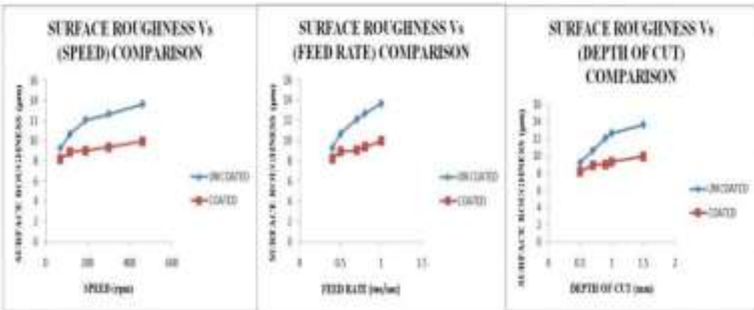

Figure 4.2: Comparison graphs for surface roughness Vs machining parameters

Above plot is for surface roughness Vs speed, feed rate and depth of cut. The results show that coated tool bit and compared with uncoated tool bit is exhibiting good properties. When compared with the former. Increases in surface roughness are observed in coated tool bit.

4.3 Tool Wear:

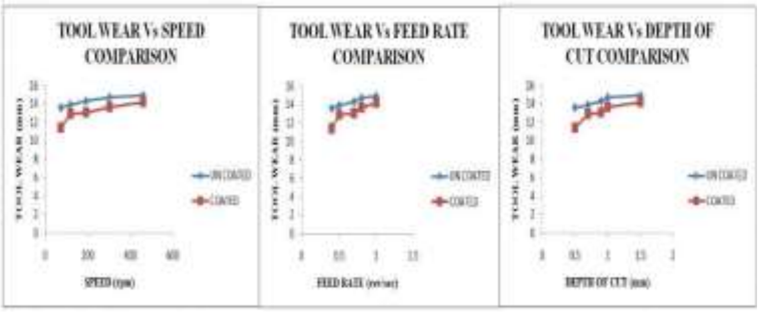

Figure 4.3: Comparison graphs for Tool wear Vs machining parameters

Above plot is for tool wear Vs speed, feed rate, depth of cut. The results show that coated tool bit and compared with uncoated tool bit is exhibiting good properties. When compared with the former. Decreases in tool wear rate are observed in coated tool bit.

CONCLUSION

The machining performance of HSS cutting tool inserts in turning EN-24 steel. Uncoated, MWCNT coated tools were examined and their flank wear and the resultant machined work piece surface finish and metal removal rate were analyzed. The tool coatings were found to improve upon the wear resistance of the cutting tool. This was shown by the decrease in wear on the flank face of the coated tools compared to that of the uncoated tool. In the case of the machined surface roughness, all the coated tools produced lower surface roughness than that produced by the uncoated tool.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

REFERENCES

[1] **Y.Sahin, G.Sur** "The TIN23 and (C,N) based CVD coatings effect Ti on tool wear in machining metal matrix composites"

[2] "Effect of Machining Parameters on the Surface Roughness while Turning Particulate Composites" by **Prakash Rao, Bhagyashekar, Narendraviswanath.**

[3] **S.V. Kadam, M.G. Rathi** Dept. of Mechanical Engineering., G. E. C, Aurangabad, MH, India published a paper named "Review on different approaches of tool life"

[4] **M.Narasimha, D.Tewodros, R.Rejikumar** Department of Mechanical Engineering, Wolaita SodoUniversity WolaitaSodo, Ethiopia. School of Mechanical and Industrial Engineering, Bahir Dar University, Bahir Dar, Ethiopia had published on a paper named "Improving Wear Resistance of Cutting Tool by coating".

[5] "Electroplating and its usage" Written by **Ken Osborne**, Metal Protection Ltd, Auckland, with editing by **John Packer**.

[6] A review paper on "Study and analysis of effect of coating on HSS cutting tool" by Assistant Prof. **Abrar A. Arshi**, Assistant Prof. **Atish Dighewar** Department of Mechanical Engineering, Babasaheb Naik College of Engineering, Pusad Maharashtra, Pincode-445215, India.

[7] A paper on "Multi-Walled Carbon Nanotube Coatings Using Electrophoretic Deposition" by **B.J.C. Thomas** and **A. R. Boccacciniw**, Department of Materials, Imperial College London, London SW7 2BP, U.K. M. S. P. Shafferw, Department of Chemistry, Imperial College London, London SW7 AZ, U.K.

[8] "Performance of Coated Carbide Tools" by **M. Narasimha, R. Reiji Kumar, Achamyelehaemro Kassie** School of Mechanical and Industrial Engineering, Bahir Dar University, Bahir Dar, Ethiopia.