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Experimental and Finite Elemental Analysis of Nano Coated Carbide Tool

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Abstract — Novel material system for coatings on cutting tools, towards accomplishing clean manufacturing, i.e., without the use of cutting fluid, are presented. They involve use of multilayer Nano coating architectures of carbide / metal or solid lubricant / metal on cemented carbide tools by physical vapour deposition (PVD) process, namely magnetron sputtering. By providing numerous (literally hundreds of layers) alternate nano layers of hard and tough, hard and hard, or solid lubricating and tough materials, it is possible to take advantage of the unique properties of nanostructures namely, higher hardness, higher strength, higher modulus, higher wear resistance, higher fracture toughness, higher chemical stability, and reduced friction than their counterparts where the coating layer thickness is in the micrometer range. Various features of these coatings are discussed from the point of view of their application in dry machining

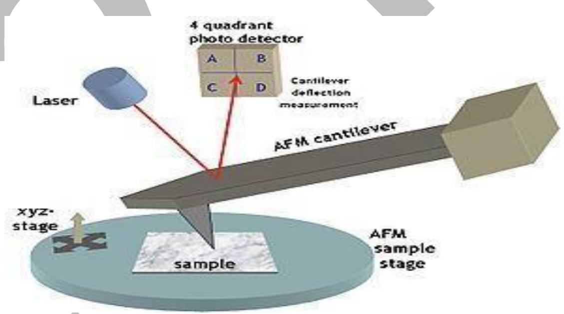
Keywords— carbide, nano structures, coatings.

I. Introduction

Nanotech is the study of the control of matter on an atomic and molecular scale. Generally nanotechnology deals with structures of the size 100 nanometers or smaller, and involves developing materials or devices within that size. Nanotechnology is very diverse, ranging from novel extensions of conventional device physics. There has been much debate on the future of implications of nanotechnology. Nanotechnology has the potential to create many new materials and devices with wide-ranging applications, such as in medicine, electronics, and energy production. On the other hand, nanotechnology raises many of the same issues as with any introduction of new technology, including concerns about the toxicity and environmental impact of nonmaterial, and their potential effects on global economics, as well as speculation about various doomsday scenarios. An experiment indicating that positional molecular assembly is possible was performed by Ho and Lee at Cornell University in 1999. They used a scanning tunnelling microscope to move an individual carbon monoxide molecule (CO) to an individual iron atom (Fe) sitting on a flat silver crystal, and chemically bound the CO to the Fe by applying a voltage

II. Tools and techniques

A microfabricated cantilever with a sharp tip is deflected by features on a sample surface, much like in a phonograph but on a much smaller scale. A



laser beam reflects off the backside of the cantilever into a set of photo detectors, allowing the deflection to be measured and assembled into an image of the surface. The first observations and size measurements of nano-particles were made during the first decade of the 20th century. They are mostly associated with the name of Zsigmondy who made detailed studies of gold sols and other nanomaterials with sizes down to 10 nm and less. He published a book in 1914. He used ultramicroscope that employs a dark field method for seeing particles with sizes much less than light wavelength. There are traditional techniques developed during 20th century in Interface and Colloid Science for characterizing nanomaterials

III. OBJECTIVES OF THE PROJECT

To optimise the nano coated tool deformation using taguchi’s technique in selected range of machining parameters. To build a finite element model of the hard turning process in the updated lagrangian formation using ANSYS finite element software to study the effect of cutting parameters on tool effective stress, temperatures, and strain at chip tool interface. To find the influence of machining parameters on cutting force using SN, MEAN RATIO. To study the effect of nano coating on cutting forces, interfacial temperatures, tool effective stress,

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effective stress, and effective strain at tool chip interface using FEM.

IV. Effects and Optimization Of Machining Parameters In Hard Turning Process

In today's rapidly changing state in metal cutting industries, applications of optimization techniques in hard turning processes is essential for a manufacturing unit to replace grinding/finishing operations due to the development of advanced tool materials and rigid machine tools, which can ensure the same accurate geometrical and dimensional tolerances. The complex machining process gets influenced by multiple process parameters, particularly in a finish hard turning operation, which often determines the final quality of the parts. This article presents a brief review of the techniques of modelling. The main objectives of this study investigate and evaluate the effect of different machining parameters on surface roughness, tool wear, tool life, cutting forces, power consumption, material removal rate and cutting temperature and chip morphology during turning of different hard steels with hardness more than 45 HRC.

Physical Properties:

Density	7.83 – 8.08 g/cc

Mechanical Properties

Rockwell Hardness	30.0 – 60.0
Vicker's Hardness	301 – 604
Ultimate Tensile strength	840 – 2450 Mpa
Yield Tensile Strength	655 – 2400 Mpa
Modulus of Elasticity	183 – 200 Gpa
Bulk Modulus	140 Gpa
Poisson Ratio	.300
Shear Modulus	70.0 – 77.0 Gpa

Thermal Properties

Thermal Conductivity	17.0 – 27.0 W/mk
CTE,Linear	10.0 – 11.3 µm/m-ºC

Composoition:

Material	Composition
Carbon (C)	0.90-1.20
Manganese (Mn)	0.30-0.75
Phosphorous (P)	.005 - .01
Silicon (Si)	0.1-0.35
Sulfur (S)	.05
Cromium(Cr)	1-1.6

V.Optimization of hard turning process parameters With PCBN tool based on the Taguchi method

In this paper, the Taguchi method is applied to find optimum process parameters for hard turning of hardened steel AISI 4142 using PCBN tool. Orthogonal design signal-to-noise ratio and analysis of variance (ANOVA) are applied to study performance characteristics of cutting parameters (cutting speed, feed and depth of cut) with consideration of surface roughness. Significant factors affecting surface roughness were identified, and the optimal cutting combination was determined by seeking the best surface roughness (response) and signal-to-noise ratio. Using multiple regression the exponential, first order linear and second order prediction models were obtained to find the correlation between surface roughness and independent variables. Finally, confirmation tests verified that the Taguchi design was successful in optimizing turning parameters for surface roughness.

Selection Of Levels For The Factor

	Factors/Parameters name	Level 1	Level 2	Level 3
A	Cutting speed(m/min)	225	330	350
B	Feed(mm/rev)	0.05	0.75	1

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C	Depth of cut	1	2	3

The following parameters were kept fixed during the entire experiment.

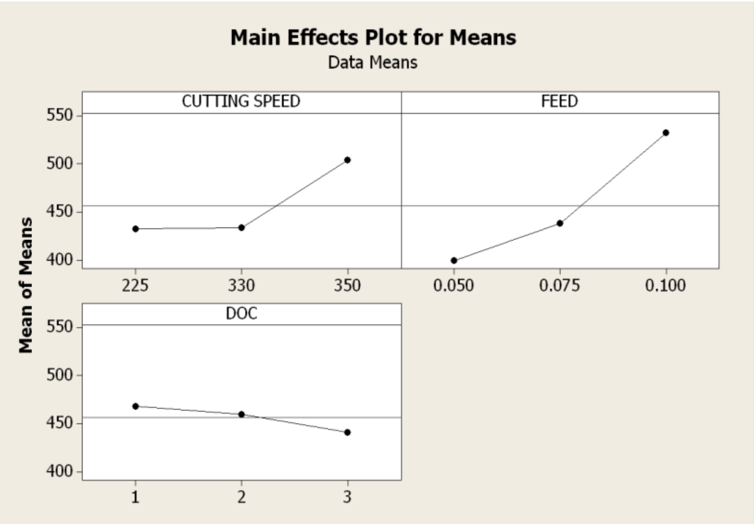
Work piece material : AISI 52100Alloy Steel (En31)

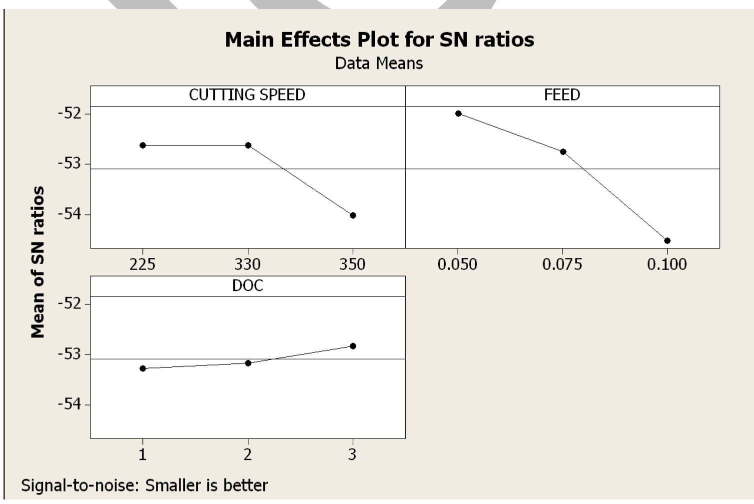
Work piece condition: : Hardened to 55HRC

Insert geometry : CCMT 21.51 Insert

Insert material : Tungsten Carbide

Cutting condition : Dry





CONCLUSIONS

Nano coated tool is optimized using Taguchi technique and the optimum Cutting levels found from this experimental study are,

1. Cutting speed = 225 m/min
2. Feed rate= 0.05 mm/rev
3. Depth of cut= 3 mm
4. Hard turning process is modelled using updated ANSYS, and the values of simulated cutting forces are found to be in agreement with experimental cutting forces.
5. Finite element simulation is conducted for nine cutting conditions and the effect of cutting parameters on tool effective stress, interfacial temperature, effective strain and cutting forces is studied.

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