Mechanical and Microstructural Properties of TiAlN Monolayer Coating on Tungsten Carbide Cutting Tool Inserts

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***Abstract*—Metallic Nano coating on cutting tools are an effective way for improving tool performance while machining difficult to machine materials. The need for high productivity and accuracy in metal machining has leads to the development of hard coatings on the cutting tools. Traditionally hard tool materials are unable to achieve all the properties such as high hardness, low wear rate, long tool life, and good surface finish at the same time and at the highest level. In order to increase the life of the cutting tools thin hard film coating is introduced on the cutting tool. Inserts of coated with single layer of metallic nano particles (TiAlN) by magnetron sputter method. SinceTiAlN coating has shown lower resistance to Tungsten carbide (WC) and less material damage than generated stiffness (24.47 GPa), according to evaluations of high-rise models.**

***IndexTerms*—Nano Coating, TiAlN, Magnetron sputter method, Tungsten Carbide.**

I. INTRODUCTION

Coating on cutting tool is an effective due to perfecting tool performance while fabricate hard to machine substances. The must have for inordinate productivity also delicacy in amalgamation fabricate has finishes up within the event of hard coatings on the wounding tools. Hard coatings have a further range of scientific uses outstanding to their developed mechanical, Tribological, natural also physical things. In now a days wear flexible high hard coverings in solitary film also multifilm system apply that got an devilish crack through in amalgamation wounding assiduity (1). The hard/ easy covering include a lower inner Stress TiAlN (rigid film) of medium micro hardness also less measure of disunion (2). Conducted experimental working desiccated revolving of austenitic pristine brands cemented carbide material covered through TiCN/ Idiosyncrasy/ Al2O3 also Idiosyncrasy/ TiCN/ Drum multifilm coverings, also initiate that the crafted apparent smoothness norms are grandiose through the coating swiftness(3).The damage and gash performance also continuance of a tool delivered through a face film/ carbide tool through the inordinate stylish admixture of the covering/ substrate things (4). The mechanical Tribological things of nanostructured Drum/ TiBN multifilm coating as a purpose of bifilm consistence equipped by at temperature through responsive unstable magnetron sputtering in an N2-Ar gas combination consume considered (5).

The binary regression computations attained aimed at face smoothness also material removal rate(MRR) through regard to fabricate through an uncovered tools also also through carpeted tools are enhanced in every through since them similar as colorful purposes, it may be attributed to the detail that the top skill-off resolution are exorbitantly delicate towards the norms rehearsed (6). This process containing colorful records of the COF, also visualizations of wear accoutrements also the uses of PVD-TiAlN carpeted inserts (7). The wounding performance of SiAlN slipup wounding inserts was developed through generating TiCN coverings on the supplements of nickel- innovated compound revolving in withered situations also the position of frictional wear of coated insert is low when compared to the uncoated inserts (8). The outgrowth of the wounding swiftness pacing a device continuance also the wear ministry, the face excellence of the crafted work pieces were calculated through a sequences of turning trials (9). The proliferation of feed quantum increase the energy, face roughness also tool wear rate are bettered as wounding haste increased also declined for energy (10).

II. MATERIALS USED

Tungsten carbide (WC) is a chemical compound (particularly, a carbide) that contains equal amount of carbon and tungsten atoms. Tungsten carbide is a fine grey powder in its most basic form, but it may be pressed and moulded into shapes for use in industrial machines, cuttingtools, chisels, abrasives, armor-piercing shells, and jewellery through sintering. With a Young's modulus of approximately 530–700 GPa, tungsten carbide is roughly twice as rigid as steel and has a density that is roughly halfway between lead and gold. It has a hardness comparable to corundum (Al2O3) and can only be polished and completed using high-hardness abrasives such as cubic boron nitride and diamond powder, wheels, and compounds.

Double-sided 80° rhombic wiper inserts for prime surface finish at high feed turning (0.3 to 0.6 mm/rev). Three to 5 times better surface finish compared to plain turning inserts at the identical feeds. this sort of cutting insert secure good innovative for medium and semi roughing on steel and forged iron and chrome steel.

Uncoated CNMG 120408-M4 TK1501insert

TiAlN could be a coating with excellent hardness and high thermal and oxidation resistance. Incorporation of aluminum resulted in a rise of the thermal resistance of this composite PVD coating with reference to the quality TiN coating by 100°C.

Material	Ti	Al	Si	N
TiAlN	27.02	26.86	-	46.12

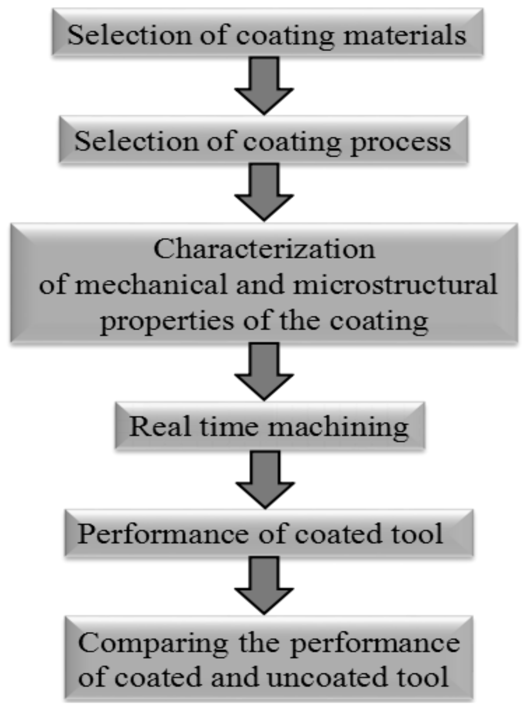
Biological composition of TiAlN

TiAlN is usually coated on high speed cutting tools used on CNC machines for machining of materials of upper toughness and at severe cutting conditions. It is suitable for drill bits, hard metal milling cutters, cutting inserts and shaping knives. It is utilized in dry or near-dry machining applications.

Properties	value
Hardness	32 GPa,
Thickness	1-4 micrometers
Coefficient of friction	0.5
Thermal stability	600°C

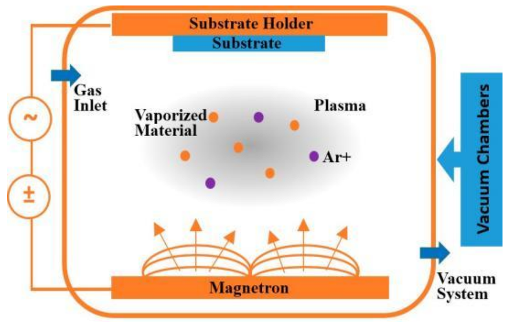
Properties of Titanium Aluminium Nitride

III. METHODOLOGY



Methodology of the project

Magnetron sputtering technique is a high-rate vaccum coating method it allows to deposit on many types of materials which includes metals and composite, onto as large number of substrate materials by using the a specially formed field of magnetic applied to a diode of sputtering target. Magnetron sputtering deposition method of use magnets on the side of negative cathode to capture electrons over the negatively energized target material so they are not free to strike the substrate, allowing for faster deposition rates.



Magnetron sputter method

Coating Deposition Parameters	
Substrate Temperature	673-973 k
Distance Between Target and Substrate	6.5 cm
Bass pressure	1.2*10^-3 Pa
N_2 Flow Rate	2-30 sccm
Ar Flow Rate	10-38 sccm
Total Flow Rate	40 sccm
Working Pressure	0.75 Pa
Target Voltage	300-350 V
Plasma Current	200 mA
Deposition Time	60 min
Target	TiAlN

Coating Deposition Parameters

We used stainless steel 304 as a workpiece tool for machining, we machined the stainless steel 304 for 30 miniutes both coated and uncoated tool at a feed of 0.15 mm and depth cut is 1mm with a cutting speed of 1500 rpm.

TiAlN Coated CNMG 120408-M4 TK150 insert

IV. RESULT AND DISCUSSION

Microstructural evaluation ranges from simple determination of certain parameters like grain size or coating thickness through porosity and pore structure to full characterization of multi-component systems or evaluation of degradation or failure mechanisms. a mixture of techniques are accustomed provide both physical and chemical information, with sub-micron resolution.The figure (1) and (2) shows the microstructure image of cutting tool without coating, figure(1) shows the 400 X, Etched image of the uncoated carbide tool, figure (2) shows the 1000 X Etched image of uncoated carbide tool.

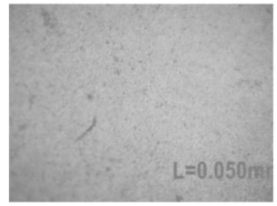


Figure 1 Figure 2

The figure (3) and (4) shows the microstructure image of cutting tool without coating, figure(3) shows the 400 X, Etched image of the TiAlN coated carbide tool, figure (4) shows the 1000 X Etched image of TiAlN coated carbide tool.

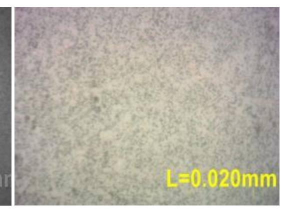


Figure 3 Figure 4

Figure 5 shows the vickers hardness test (HV) table for the TiAlN coated and uncoated tungsten carbide cutting tool insert and figure 6 shows the line graph for the vickers hardness test.

S.No	Cutting Tool With Coating	Cutting Tool With Out Coating
1	1642.7	1632.9
2	1613.7	1576.9
3	1734.3	1604.7
Average	**1663.6**	**1604.7**

Figure 5 Table For Vickers Hardness Test(HV)

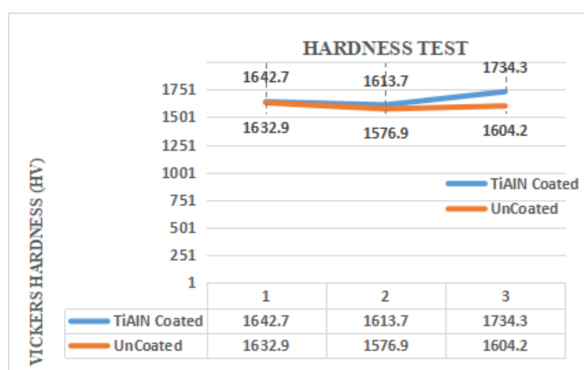
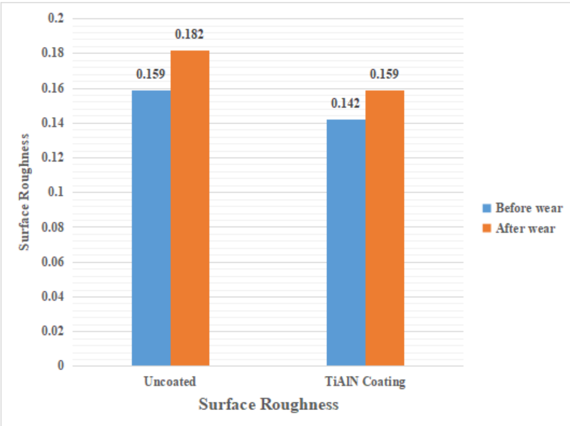


Figure 6 Line Graph fot the Vickers Hardness Test (HV)

Figure 7 shows the surface roughness test for the coated and uncoated carbide tool it seems the hardness of the TiAlN coated carbide tool has better hardness than uncoated carbide tool.



V. CONCLUSION

TiAlN monolayer coverings be situated positively dumped through magnetron sputter method proceeding tungsten carbide wounding device insertion. Greater rigidity (24.47 GPa) stood detected designed for the single film (TiAlN) coverings. That one stood similarly observed that TiAlN covering exposed well development in apparel amount (52%) associated towards the uncovered device. Improved amount of films in multifilm covering improved the exterior similarity then as per an outcome worthy exterior quality (0.219 µm) stood attained.

Properties on wear rate, coefficient of resistance, scratch resistance has to be determined in the next phase. Microscopic structure of coated and uncoated tool has to be taken for the coated tools to identify the presence of coated Nano materials. After this, real time machining has to be done and their performance has to be measured.

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