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Study of Corrosion Behaviour of Tungsten Carbide, Aluminium Chromo Nitride Coated and Diamond Like Carbone Coated End Milling Insert

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Abstract : The main objective of this research was to study the properties of tungsten carbide end milling insert with and without coating. The tungsten carbide without coating (UNC), Aluminium Chromium Nitride (AP3) and Diamond like Carbon (DLC) is a coating insert is carried out in this work. The corrosion test is carried out two chemicals namely base and acid media. Base is sodium carbonate and acid is Hydrochloric acid. The weight loss method is applied in the work. Additional the microstructures were carried out using Scanning Electron Microscope (SEM). The result shows that the DLC coated tool gives less corrosion.
Key words: coated insert, base, acid, inserts.

1. Introduction

Increasing the demand for high speed and high performance of dry machining applications need for high quality tool material is required. While machining in dry cutting condition the tool get more stress and temperature in oxidizing in air atmosphere the cutting tool gets wear, tool life and efficiency are reduced. Also affect the production and productivity. To improve the machining properties of new material coated tools and inserts was introduced. To implement the coating methods the hardness and friction resistant are improved and reduced corrosion [1-5].

Innovative writing on the corrosion actions of cemented carbides is comparatively wide (6-15). As of these studies, several microstructure effects on corrosion response for these materials may be decorated. First, in neutral and acidic solutions, corrosion in cemented carbides proceeds through careful binder leakage, whereas the tungsten particles are not much precious by the corrosion show aggression. This is not the case at alkaline pH, where the metallic binder passiveness and tungsten Carbone shows active dissolution. Second, ring binder chemical nature has a large influence in the corrosion struggle of hard metals. In this view, it is known that accumulation of elements such as Ni, Mo,Co and Cr. In the Co binder phase normally enhances corrosion opposition. Third, grain size property depend on the surroundings acidity, with microstructure refining yielding a beneficial effect on corrosion resistance less than conditions in which the Co binder undergoes active or passive-transition.

While machining coolants are used due to reduced in the wear and improve the tool life but the coolant having some chemical composition to react with tool materials to get corrosion duet to avoid the ecological problems and reduced the corrosion the machining are used in dry condission.The corrosion is occur in the tool tip due to the machining the work piece get more roughness and affect the quality of the product. So Carbone and coated inserts are used.

Saravanan et.al[16] studied the corrosion behaviour of aluminium alloy of 6063 and surface methodology is studied using SEM image. The result shows AA6063 with 10% of cenosphere as it possesses high corrosion resistance property. Thyla et.al[17] studied the corrosion behaviour of Al6061matrix with nanoZrO2, micro SiC and Graphite (Gr) reinforcement's nano hybrid composite. The five different samples were prepared, including the pure Al 6061 matrix to analyze the corrosion behaviour. The best combined reinforcement for the developed new nano hybrid composite was 9 % of the combined reinforcement sample. Gnanasekaran et.al [18] All the TIG and A-TIG welds were analyzed to study the corrosion behaviour of weld bead geometry were determined by using potentio dynamic polarization test The results indicated that the specimens welded with oxidized surface showed minimum rate of corrosion when compared to conventional TIG and A-TIG welded specimens. The results indicated that the specimens welded with oxidized surface showed minimum rate of corrosion when compared to conventional TIG and A-TIG welded specimens.

Thamotharan et.al [19] In order to further enhance tribological properties 316 Low carbon stainless steel (L SS) used on mechanical parts. CrN/TiN with DC magnetron sputtering sources was carried out on PVD 316 L SS. Scanning electron microscope (SEM), X-ray Diffraction (XRD) and tribology properties were investigated on a Pin on Disc friction and wear tester under dry sliding conditions. The results of the tests revealed that CrN/TiN exhibited a lower wear loss compared to the plain 316 LSS.

Kumar et.al [20] is reviewed the corrosion inhibition of steel with emphasis on acidic media. This review provides us information about how organic molecules get adsorbed on the metal surface and form a barrier film over its surface. Mary et.al [21] considered the nature of the metal surface has been analyzed by Fourier transform infrared spectroscopy (FTIR), Scanning electron microscopy (SEM) and Energy dispersive x-ray detector (EDAX) measurements. Sathishkumar et.al [22] their work is dealt with successful development of cerium substituted hydroxyapatite (Ce-HAP) on borate passivated 316LSS. The coatings were characterized by Fourier transform infrared spectroscopy (FT-IR), X-ray diffraction (XRD), scanning electron microscopy (SEM) and energy dispersive X-ray analysis (EDAX). Baskaret.al [23] considered the surface and structural morphology of the coated film were analyzed by using SEM and XRD.

Mariappan et.al [24] investigation two compositions of duplex stainless steels (DSS) were obtained from pre alloyed 316L and 430L powders along with controlled addition of Cr, Mo and Ni through powder metallurgy route and SEM images. Laxmanan et.al [25] analysed the structure of the copolymer was systematically studied by IR, NMR and X-ray powder diffraction (XRD) , and the surface morphology was studied using SEM analysis. Ramyaa et.al [26] considered the surgical grade stainless steel (316L SS) is a widely used bio metallic implant material in orthopaedic applications and also studied the XRD. Sundaram et.al [27] applied the primary objective of this study is to examine the corrosion inhibition performance of uinoline-8-sulphonyl chloride (QSC) on Mild Steel in 1 M H2SO4 solution by electrochemical, weight loss, Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray spectroscopy (EDX) methods. The above literature shows the corrosion and images are important in all metals and materials. That's way we are planned to apply the corrosion and SEM images for cutting inserts.

2. Physical Vapors Deposition (PVD)

If the materials is taken in solid state, but send a small particles or atoms and deposited on the wafer any reaction, it is called Physical vapor deposition (PVD).PVD also called sputtering. Aluminum Chromium Nitride and Diamond like Carbon are deposited on tungsten carbide insert using PVD system Bias and Cathode arc evaporation (Orilicon Blazers). The PVD coating process carried out different steps are involved. The first step is cleaning process, this process carried out in two method one is rough cleaning and UV cleaning methods. First the vapor champers removing the air from the champers and apply the vacuum. The argon gas is applied inside the champers to maintain low pressure. High voltage is applied in the plate, plasma is generated. The positive argon ions will be attracted towards the Negative plates and hit the tungsten with high force. The sputtering process carried out uniformly from the base material and coating in all direction with 3μm. Finally

cool the material and check the quality of the product. In this process carried out from Orlikon blazer coating industries. The Aluminum Chromium Nitride (AP3) and DLC coating process carried out in this method.

3. Experimental procesuder

Corrosion may be defined as "The destruction of a material by chemical, electrochemical, or metallurgical interaction between the environment and the materials". Generally it is slow but persistent in character. In some cases, the products of corrosion are bulky and porous in character, offering no production .One of the most series problems of industries it is affects the quality. To avoid the corrosion, coating materials are used. In this research uncoated, AP3 and DLC coated milling inserts are used for machining.

The corrosion test carried out by weight loss method. It's old method and gives very accurate results. The method is commonly used as a calibration standard that means of corrosion monitoring like linear polarization and electrical resistance. The experiment carried out two chemical medium namely, base medium and acid medium. The Fig1 shows the arrangement of tools in acid condition .The base medium is sodium carbonate (Na_2Co_3) and acid medium is HCL (Hydrochloric acid).The initial weight is taken for the cutting tool and immersed in acid and based medium. After 15 days measured the weight, there is no change in the measurements. But some changes formed in the microstructure. Microstructure also studied with help of SEM. The different images are compared and tabulated in figure. Weight loss calculated using Eq.(1).

$$\text{Weight Loss (\%)} = \frac{\text{INITIAL WEIGHT} - \text{FINAL WEIGHT}}{\text{INITIAL WEIGHT}} \text{ X } 100 \quad \text{---------- (1)}$$

Acid Solution – HCl (Hydrochloric acid), Base Solution – Na_2CO_3 (Sodium Carbonate)

Fig 2 Arrangement of corrosion test on Acid medium

4. Result and discussion

The tool in 15 days (360 Hours) immersed in the base and acid materials the weight results shows on Table.1. The result shows that no corrosion occurs in the acid medium .In base, no change in the weight. The result shows coating is perfectly carried out in cutting inserts.

Table 1.Corrossion values

S.No	Acid Media		Difference	Base Media		Difference
	Before	After		Before	After	
Uncoated	1.805	1.802	0.003	1.843	1.845	-0.002
AP3	1.849	1.847	0.002	1.832	1.832	0
DLC	1.854	1.854	0	1.835	1.836	-0.001

The SEM image are compared with in normal insert, acid and base media insert shown in Fig 1 (a), (b) and (c).The SEM image are compared in UNC, AP3 and DLC. AP3 slight increasing in corrosion at acid. Pitting corrosion due to immersed in acid, base. Cavitations corrosion appeared in the tool in acid and base

media. The image in acid immersed tool forming deep pits, depressions, and pockmarks, Coring, crevices are occurred the tool. The different corrosion effects shown fig.2 was UNC acid tool. If a inserts placed inside of HCL vigorous bubbling formed in all cutting tool.

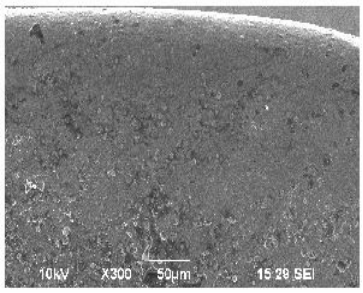
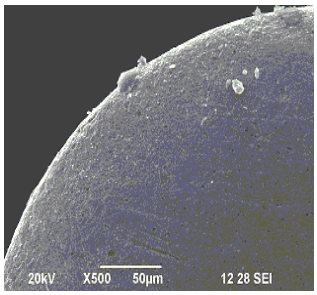
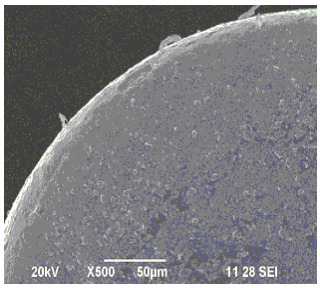
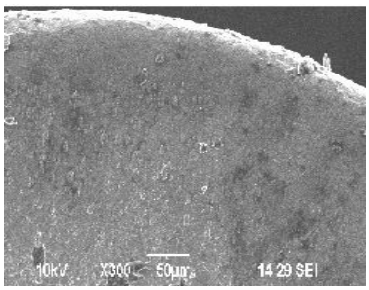
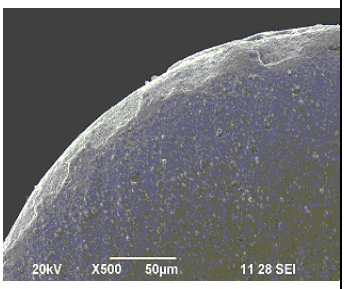
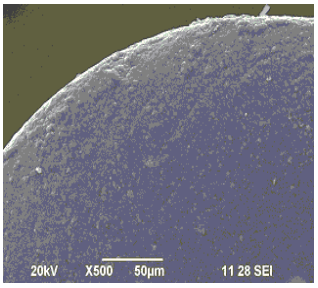
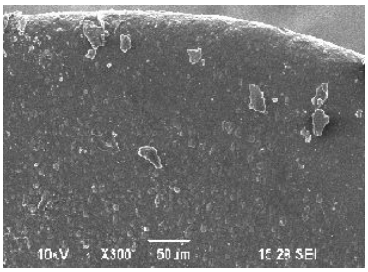
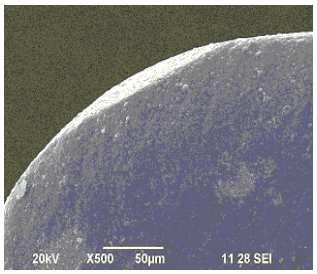
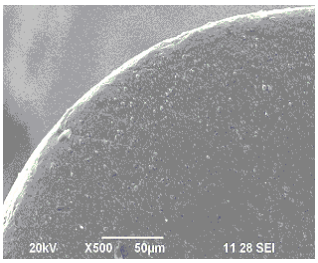
S. NO	Material	(a)Normal insert	(b)Acid	(c)Base
1	UNC			
2	Ap3			
3	Dlc			

Fig 1.SEM images of UNC, AP3, DLC (a) New insert (b) after immersion of HCL (c) After Imerssion of NaOH

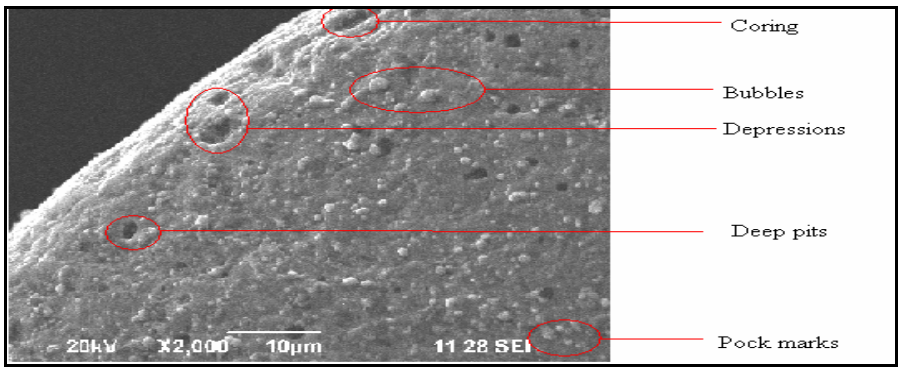


Fig.2 SEM image of acid uncoated insert

5. Conclusions

The following conclusions are drawn from the above the resultant discussion.

1. The weight loss method is very suitable for the corrosion test in the machine tools.
2. The base and acid media is carried out in the research work. The corrosion values are very close in the base and acid medium. There is no loss in the DLC coating in the acid medium. The weight of Ap3 and UNC tools corrosion values are very close.
3. The base immersed inserts are less coring , depressions and pock marks are formed in the inserter surface. The DLC coating is very less coring, depressions and pock marks occurred.
4. In acid immersed inserts are more deep pits, pock marks and bubbles are formed in the uncoated insert and aluminium chromo nitride coated inserts. The Diamond like Carbone coated inserts less bubbles, pock marks and deep pits are is formed.
5. The diamond like Carbone coated milling insert is very suitable in the coolant and dry condition.

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