International Journal of ChemTech Research
CODEN (USA): IJCRGG ISSN : 0974-4290
Vol.6, No.6, pp 3284-3286, Aug-Sep 2014

ICMCT-2014 [10th – 12th March 2014]
International Conference on Materials and Characterization Techniques

Characterization of CrN/TiN PVD Coatings on 316L Stainless Steel

Thamotharan.J* and Sarala.R,

**Department of mechanical engineering,
A.C.College of Engineering and Technology, Karaikudi, Tamilnadu, India.**

***Corres.author: thamu2404@gmail.com**

Abstract: 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. The micro structure of the CrN/TiN coatings were investigated by 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 L SS, Additionally, the wear loss of the coated specimens decreased with increasing applied load and sliding time, and a low friction coefficient and low wear loss were achieved. The double layered CrN/TiN deposition showed the greatest improvement in tribological performance.
Keywords: Tribology, PVD coating, TiN/CrN and 316 L SS.

Introduction

The high strength, low weight, heat Conductivity, high strength, low gas permeability and good corrosion resistance possessed by Stainless steel (SS) have led to a wide and diversified range of successful applications, which demand high levels of reliable performance in medical implants and marine applications. The stainless steel L 316 is low in wear resistance, engineering components made from the same seeks improvement in wear resistance[1,2] .When 316 L are sliding itself in air atmosphere, it is suffering from severe metallic wear, surface damage and subsurface plastic deformation due to the formation of strong adhesion bonds at the contact junctions[3,4].Although austenitic stainless steel works well at high temperatures atmosphere, its components are failed due to sliding wear rather than failure due to high temperature problems orcorrosion related problems. Moreover, the metals are in sliding contact in high vacuum atmosphere exhibits tribological problems of high friction, stick -slip motion and high wear, due to stronger adhesion between the surfaces than in air. And it is required high mechanical force or strength to separate the surfaces in contact[5] When Compared to other coating processes like the CVD process, the PVD process is advantageous because of it low process temperature, which do not affect the microstructure and hardness of the substrate [6]. Titanium nitride coating and chromium nitride coatings have high hardness, good wear and corrosion resistance and have been used as wear résistance. In this study, the tribological behavior of L 316 substrates has been studied by pin-on-disc tribo meter under varying normal loads and dry sliding contact conditions.

Materials and Experimental test conditions

Sample preparation

Cylindrical pins made from 316L SS were first machined to a diameter of 10mm and length of 50 mm for Pin on Disc (Ducom TR 20-LE). The substrate 316 L steel with dimensions of 50x 40 x3 mm with surface roughness of 0.108µm and micro hardness of 312.76 Hv with elements composition of wt. % C: 0.025, Ni: 12, Cr: 17.5, Si: 0.2, N: 0.06, Mn: 1.7, Mo: 2.2 and Fe: Balance

Surface coating

Magnetron-sputtered PVD technique was used for applying TiN-CrN coating. The coating was performed at the temperature of 300^0C in nitrogen atmosphere, at the deposition pressure of 3.5 Pa and nitrogen gas flow 10 sccm. The coating deposited over the surface was observed by SEM and X-RD. The thickness of the coating was 4µm and its surface appearance was light gold in color.

Experimental test conditions

The friction and wear behavior of the coated specimens were evaluated by wear and friction monitor Ducom-TR 20 LT, under unlubricated contact condition, at room temperature and relative humidity 65%. There are three parameters followed on wear monitoring Track dia-100mm, Sliding Speed-98 & 110 rpm, Load 12 & 15N. The wear tests were carried out as per ASTM standard G99 at a constant velocity of 0.5 m/s.

Result and discussion

X-ray diffraction analysis on coated specimens

The X-ray diffraction measurements for CrN & TiN were conducted on these films shown in figure 1.the X-ray diffraction patterns of CrN &n TiN on 316 L SS substrate, in these cases the peak value of CrN was an angle of 37.5 and TiN of 36.6° respectively.

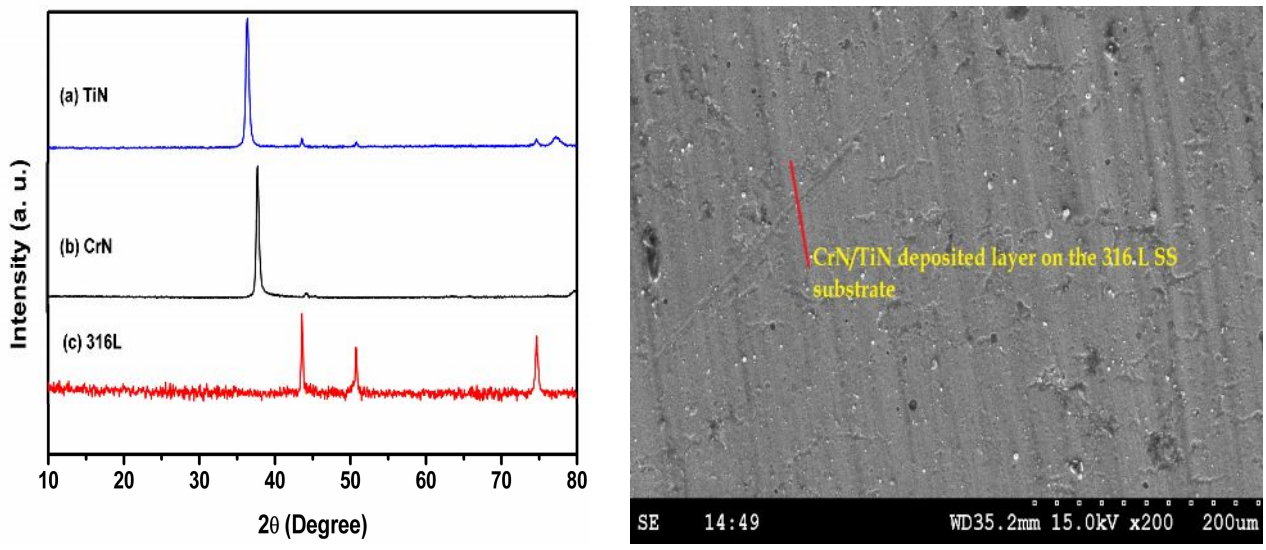


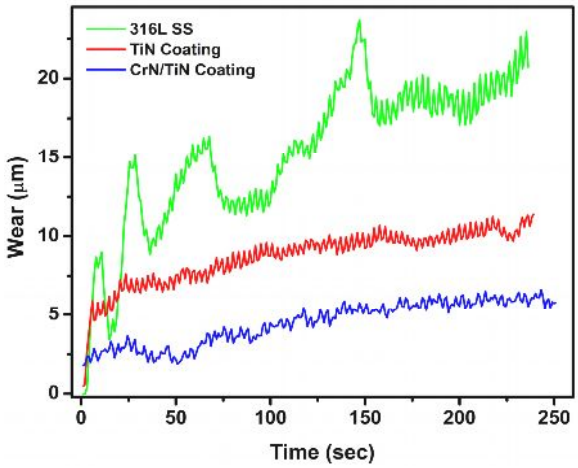
Figure 1a) X-RD diffraction pattern of 316 L SS, b) Surface image of TiN/CrN coating applied over the316 L SS substrate observed by SEM under high magnification.

Morphology analysis of coated specimens

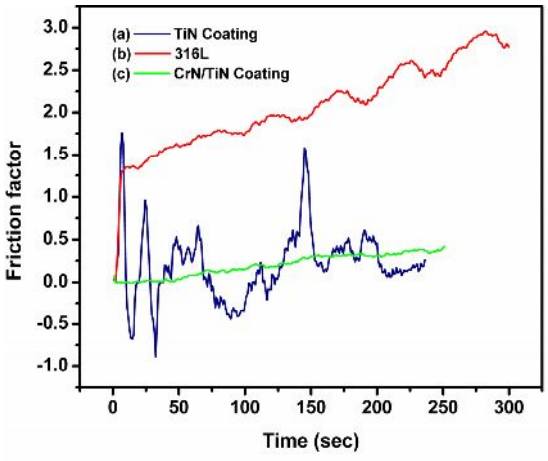
Figure 3 shows the cross-sectional view of the specimen with coating on the textured surface. The image clearly reveals the uniform distribution of coating and also confirms the presence of coating inside the dimples. The similar dispersion and microstructure of CrN/TiN coating particle deposited by physical vapor deposition (PVD) technique on 316 L SS substrate improving the surface quality.

Wear analysis of CrN/TiN coated specimens

The figure 3 a) and b) shown the wear rate corresponding to sliding time.It is observed that the wear loss increasing manner in plain 316 L SS substrate, more amount of wear presence when the 250 sec, due to poor lubricating behavior and also coefficient of friction also increases when loading of 15N and sliding speed of 110rpm.



a)



b)

Figure 3 a) Wear and b) Friction factor of coating on the textured surfaces as a function of sliding time

The single layer TiN deposition reducing the wear rate and maximum wear rate of 9μm at 230sec and TiN layer deposition improving the hardness and friction factor also reduced. In the case of double layer CrN/TiN deposition wear rate significantly reduced while plain 316 L SS substrate, when the load increasing beyond 15N wear loss slightly decreased and friction temp also reduced.

Conclusions

Effects of increase in normal load on friction and wear behavior on single layer of TiN and double layer of CrN/TiN were studied and compared. Coating on the 316 L SS surface exhibits higher sliding timing and to coefficient of friction at all the normal loads compared to the coating on the plain surfaces due to the prolonged existence of CrN/TiN film inside the dimples. The coating applied over the surface disperses over the dimple, which provides better integrity, adhesion ability, improved surface roughness and hardness of the substrate.

References

1. Bayan R, Igartua A ,Fernadez X ,Corrosion wear behavior of PVD Cr/CrN multilayer coatings for gear application, tribology international.,2009,42,591-599.
2. Rossi s, Fedrizzi L, Leoni M (TiN,Cr)N and Ti/TiN PVD coatings on 304 stainless steel substrates: wear corrosion behavior, Thin film solids,1999,350,161-167.
3. Bin Tain, Wen Yue, Zhiqiang Fu. Microstructure and tribological properties of W-implanted PVD TiN coatings on 316l SS.Vacuum, 2014, 99, 68-75.
4. Hsu K.L, Ahn T.M, Rigney D.A.Friction- wear and microstructure of unlubricated austenitic stainless steels, Wear, 1980,60, 13-37.
5. Kazuhisa Miyoshi. Foreword-Considerations in vacuum tribology (adhesion, friction, wear, and solid lubrication in vacuum), Tribology International, 1999, 32, 605-616.
6. Merklein M,schrader T,engel U Wear behavior of PVD coatings, tribology in industry, 2012, 34, 51-56.

*****