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WEAR BEHAVIOUR OF HIGH CARBON CHROMIUM STEEL

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ABSTRACT

The main aim of our project is to increase the lifetime of bearing materials particularly EN31 steel which is used in manufacturing of Ball bearings, Spinning tools, Beading Rolls, Punches and dies. EN31 is a quality high carbon alloy steel. Increase in the lifetime of a material is done either by alloying with appropriate materials before its producing. This project makes an attempt to enhance the lifetime of EN31 steel by modifying the surface through heat treatment and coating process. Wear tests were performed on untreated and treated material with the help of pin on disc equipment. The Coefficient of Friction, the wear rate and wear coefficient were determined on pins.

KEYWORDS: Nitriding, Pin on Disc, Wear rate.

1 INTRODUCTION

The main aim of this paper is to study and increase the lifetime of bearing materials, particularly EN31 Steel. High Carbon Chromium Steels are ordinarily employed in applications requiring wonderful wear resistance such as Bearings, Spinning tools, Beading Rolls, Punches and Dies. On in all the first needs within the trade is good abrasion and wear resistance in corrosion environments [1]. M. R. Hilton, R. Bauer and P. D. Fleischauer [2] investigated on the Tribiological Performance and Deformation of MoS_2 Lubricant Films and the sliding wear contact and brale indentation contacts mare investigated using the X-ray diffraction, Auger electron spectroscopy. Waldemar Alfredo [3] investigated the nitriding behavior austenitic stainless steels (AISI 304 and 316) by different cold work degrees and the resultants shows that a new layer i.e. one external layer is formed by expanded austenite with a high presence of carbon (black diffusion). Bo Wang, Shicheng Wei, Lei Guo, Yujiang Wang, Yi Liang [4] investigated the effect of sputtering power on Microstructure and corrosion properties of TiO_2 films. The results show that the anti-corrosion and antibacterial properties of TiO_2 improved with increasing sputter power. As the power is 12KW, the combination of anti-corrosion and anti-bacterial properties are maximum.

Jonah Klemm-Toole, Amy J. Clarke and Kip O. Findley [5] investigated on improving the fatigue performance of vanadium and silicon alloyed medium carbon steels after nitriding. The results were evaluated using cantilever bending fatigue testing. The result shows the combination of increased core fatigue strength and magnitude of compressive residual stress improve the fatigue performance after nitriding compared to other nitride medium carbon steel reported in literature.

Wang J, Lin Y, Fan H, Zend D, Peng Q, Shen B [6] investigated the effects of temperature on Microstructure and Wear of Salt Bath Ntirdited 17-4PH Stainless Steel. The results revealed that the microstructure and phase constituents of the nitride surface alloy are highly process condition dependent. The nitride layer depth thickened intensively with the increasing nitriding temperature. J.-E. Sundgren [7] investigated the mechanisms of reactive sputtering of titanium nitride and titanium carbide II. The films obtained were characterized by scanning electron microscopy and X-ray diffraction and through measurements of the micro hardness and electrical resistivity. The results shows that the heat of formation of the compounds plays and important role in the formation of carbide and nitride films. A high heat of formation promotes the development of large grains and dense structures.

1.1 EN 31 STEEL

Alloy steels contain different varieties of steels that exceed the composition limits of Mn, C, Mo, Si, Ni, Va, and B set for carbon steels. They are designated by AISI four-digit numbers. They respond more quickly to mechanical and heat treatments than carbon steels.

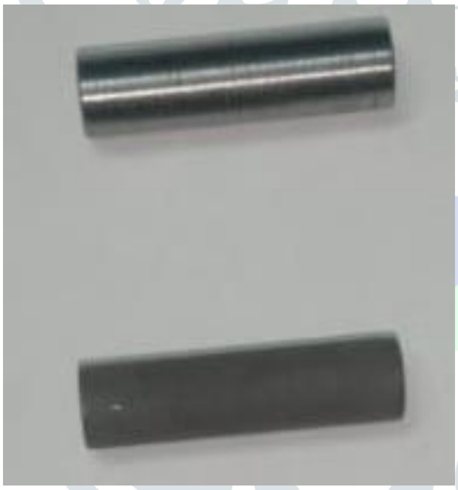

Figure 1.1: EN31 STEEL

1.2 CHEMICAL COMPOSITION

C	Cr	Si	Mn	S	P	Mo	Ni	Fe
1.08	1.46	0.25	0.53	0.015	0.022	0.06	0.33	96.25

Table 1.2: Chemical Composition of Material

2 EXPERIMENTAL WORK

2.1NITRIDING

It is a process where nitrogen is added to the surface of steel parts using dissociated ammonia as the source. A thermal diffusion process that produces metal nitrides in the surface. Process is explained in the process flow chart.

In order to check crack damages and rust prevention pin is inspected. Salt bath Nitriding process is done at 563˚ for 90 minutes. Pin is placed on the salt bath Nitriding process.

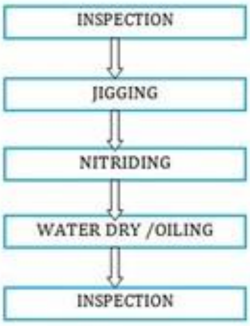

Figure 2.1: Nitriding Process Chart

2.2 SPUTTERING

Titanium nitride pH working-electrodes were prepared using an RF Magnetron sputtering system on various substrates such as alumina (Al_2O_3), glass, silicon (Si), and polyimide (PI) (plastic). Sputtered-deposition process parameters used for fabrication of metal nitride thin-films under a controlled process to produce the solid-state pH sensors with excellent performance are summarized below. Summary of the process parameters and conditions used to prepare the TiN thin film layers on various substrates.

3 PIN ON DISC

Wear performance of materials are commonly obtained from testing carried out in pin-on-disc equipment to ASTM G99 standard procedure. The photographic view of the pin on the disc is shown in. It gives a laboratory standard method to carry out sliding and abrasion wear tests. The tests were carried out under 25 N applied load and for sliding velocity of 0.3 m/s for a constant sliding radius of 10 mm. During testing the tangential force was measured by a set of the load cell and monitored by computerized data acquisition system. In all the cases coefficient of friction, wear rate and wear coefficient of the pin were estimated by taking one pins average value.

Figure 3.1: Pin on Disc Apparatus

4 RESULT AND DISCUSSION

4.1COEFFICIENT OF FRICTION

Test procedures were employed with the pin on disc tests at 0.3m/s. The wear, Frictional Force and time were obtained at a load of 25N for every 15min sliding. The Plot of friction coefficient versus sliding distance for the uncoated, Nitriding, Sputtering and Combination of Nitriding and Sputtering. This shows the Characteristic feature of the diagrams is that the friction coefficient values decreases as the Sliding distance increases at Nitriding, In Sputtering, and Combination of Nitriding and Sputtering the coefficient of friction decreases as the sliding distance increases.

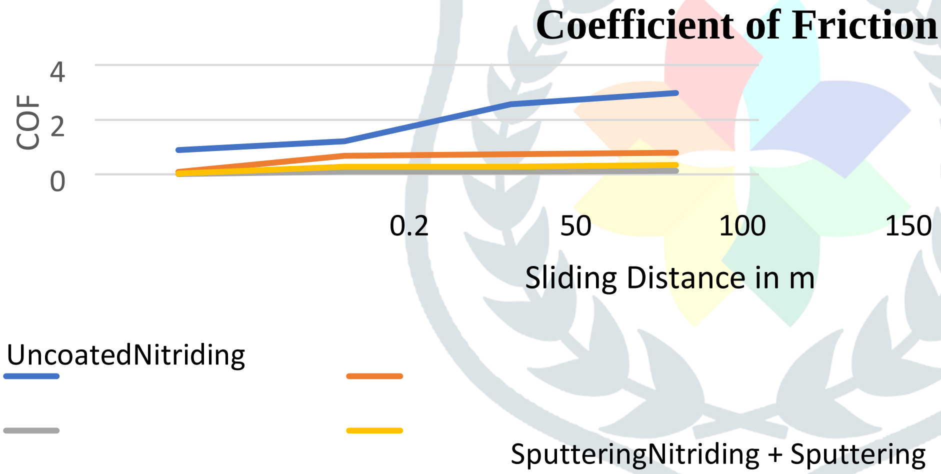

Figure 4.1: Coefficient of Friction

4.2 WEAR COEFFICIENT

Steady-state wear was proposed by Archard V=KsPL/3H where V is the volumetric loss of material after sliding for a distance L and load P normal to the wear surface. H is the Brinell hardness number of the pin while Ks a dimensionless standard wear coefficient. For known values of V, P, L, and H the standard wear coefficient can be calculated from the equation Ks=3HV/PL. Volumetric wear loss can be calculated from the weight loss W and the density.

L. J. Yang expressed that the higher initial running – in wear rate, has a higher value initially in the transient wear regime and will reach a steady – state value when the wear rate becomes constant. In Nitriding, wear coefficient decreased due to increase sliding distance. In sputtering, wear coefficient increase due to increase sliding distance. In Laser texturing, wear coefficient increases as the sliding distance increases.

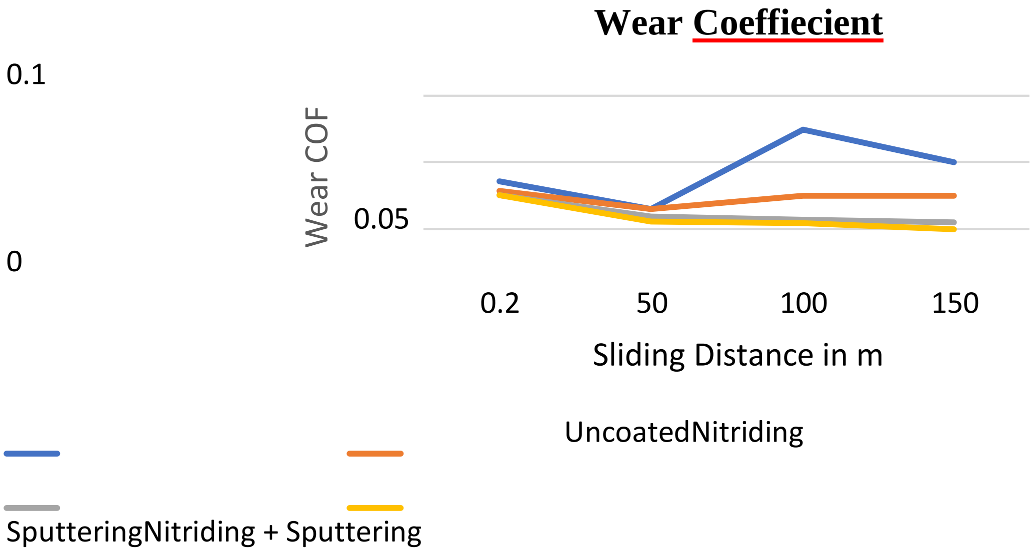

Figure 4.2: Wear Coefficient

4.3 WEAR RATE

The wear rate is calculated from the equation:

Wear Rate = Volumetric Wear Loss / Sliding Distance.

Wear rate of Nitrided coated with oil is lesser than Nitrided coated pins because of Very less Wear loss. Nitrided coated pins exhibits the less Wear rate. Wear rate of titanium nitride coated pin exhibits high wear rate when compared to uncoated pin. Wear rate of laser texturing compared uncoated material Very less Wear loss. In pins and it exhibits the less Wear rate

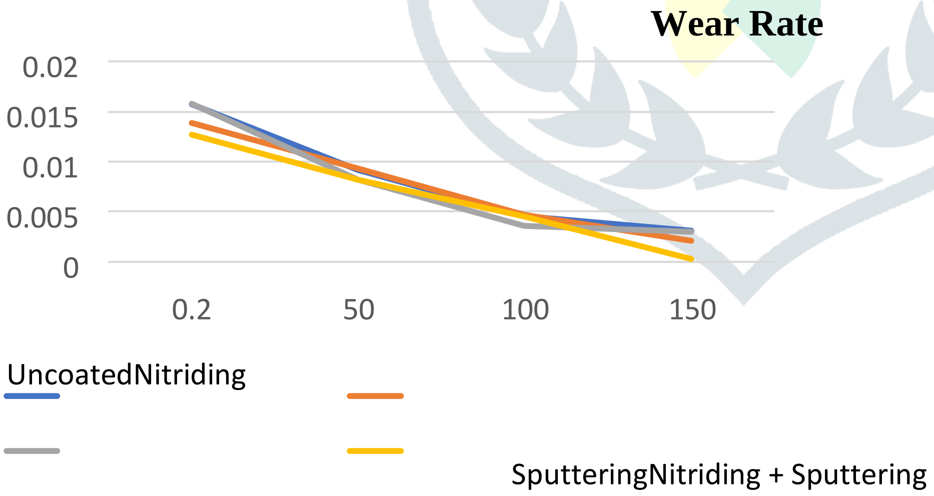

Figure 4.3: Wear Rate

5 CONCLUSIONS

The Wear coefficient of uncoated, Nitriding, Sputtering and combination of both pins were examined under 25 N loads at sliding velocity of 0.3 m/s using a pin on disc apparatus and the results are summarized as follows:

Nitriding, Sputtering and combination of both pin shows the very low coefficient of friction compared with uncoated. The coefficient of friction is around 0.33 under 25N loads with sliding velocity of 0.3 m/s. The reason is Nitriding has improved its properties in terms of both frictions and wear.

Nitriding, Sputtering and combination of both pin shows very low Wear coefficient compared with uncoated. The Wear coefficient of friction is around 4.8*10^-5 under 10 N loads with sliding velocity of 0.3 m/s.

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