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Review Article

INVESTIGATION OF MECHANICAL AND TRIBOLOGICAL PROPERTIES OF TITANIUM NITRIDE DEPOSITED ON LOW CARBON STEEL BY RF MAGNETRON SPUTTERING

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Abstract

Titanium nitride is a promising substance due to its low resistance, excessive hardness, and chemical inactivity on low carbon metal substrates due to the shimmering of the magnetron RF. Its smart productivity and low value. The purpose of this study is to study the effect of thin-film precipitation coefficients on structure, surface morphology, hardness, and wear in an aggressive circumference of 3.5% by weight of sodium chloride from TiN coating. The coating is deposited using reactive RF magnetron sputtering (13.56 MHz). They took place for 60 minutes. The structural evaluation confirmed that the TiN coating crystallized in cubic (fcc) and hexagonal (hcp) structures oriented in planes (100), (111), (200), (220) and (311). The deposited coatings existing most hardness (H=20.21GPa) and Young's modulus (E=200.79GPa Also, mechanical residences (H & E) is strongly influenced by the grain size and density tables. Comparisons revealed that electro chemical as low carbon substrate protected by the TiN coating had excellent corrosion resistance. The stoichiometric TiN film is obtained by circulating a specific polarization and a specific ionized gas in the flow (Ar) and using the optimization of the gasoline to react to the flow (N2). The XRD evaluation was used to manipulate the composition of the film. From the data obtained, the network parameters are it is calculated for each deposition and the stoichiometric film is determined. XPS evaluations of the stoichiometric film indicated that nitrogen and carbon were most often present on the surface.

Keywords: Corrosion Resistance, XRD, TiN, NaCl, Electrochemical.

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INTRODUCTION

Today there is great interest in the use of thin films of transition metal in nitride. Because of its attractive architecture properties, high hardness, adequate wear resistance, low coefficient of friction and stability, it is used in various engineering functions (cutting and forming equipment). Reduction of chemical, heat expansion, thermal conductivity and proper resistance to erosion [5]. These films are widely used to improve the surface properties and the corrosion resistance of the material. In the cutting tool industry, TiAlN films improve overall performance by forming Al2O3 / TiO2 oxide tartar and contacting hot air. In addition, the AlN components formed using Al to TiN improved the lateral stiffness [26].

They are usually separated by the activated ones. In this article, TiN layers were sprayed by RF Titan in N_2 environment. Micro hardness and adhesion were measured in the laid layers on low carbon metal and heat treated under various environmental conditions. Changes in shape and morphology for the duration of these heat treatments were followed C-TiN staining was successfully induced by RF magnetron sputtering. Combination analysis of FTIR, XRD, Raman, SEM and EDX shows that the coating consists of a mixture of TiN and TiN1-xCx phases. The current density of the coating and the number of solids bathing in the SBF solution was determined using a polarization (Icorr = 2.02 A / cm^2, ash = 0.175 A / cm^2) and a limitless antibiotic treatment. No excess (91%) coating A was obtained once. The coating was once designed designed to improve the protection of the corrosion [3-5] and Limit corrosion rate from 0.0242 mm / year to 0.0021 mm / year. TiN fabrics have a high inclination nature and are most suitable for protective coatings of the implant.

After examining the wear resistance of the titanium nitride coating, its main disadvantages are the excessive temperature and extreme thickness of the film (approximately 10 μm) occurring at certain locations in the deposit [7-8]. A viable way to overcome these problems is to use sputtering techniques, especially reactive plasma sputtering (RPS). Basically, this study suggests that TiN coatings by lowering the pH of the electrolyte are particularly inappropriate for testing bipolar plates. Physical deposition of carbon-doped titanium nitride films using HF magnetron sputtering for use in metal implant coatings [18, 23].

The thin layers of nitrous nitride were deposited on silicon substrates in response to the magnetron sprayed using multiple deposited zones. The effects on the topography exhibit that the minimal common roughness is inherent in the thin layers deposited with silicon substrates which are used for negative-90 V is applied. Demonstrations of experimental tribological, a significant increase in friction used to be extensive for the films deposited on negatively polarized substrates. The most adhesion and the attractive forces between the AFM tip and the deposited film have been decided for the films deposited for the duration of the polarization at -90 V for 20 minutes at room temperature. The values have been determined for the motion pictures deposited for 20 minutes on a substrate on a titanium buffer layer had already been deposited. Films [12-14] that have been deposited for 20 minutes at room temperature on a silicon substrate that has been exposed to a negative polarization of -90 V [12-14] are characterized through the lowest average roughness and most important mechanical and tribological properties.

The rate of increase of the reactive film sputtered with TiN increases linearly with the increase in power of the magnetron RF. At the same time, the relationship between spray rate and N2 / Ar ratio (Figure 1.a) or room temperature (Fig. 1.b) is not easy. High concentration of gas molecules prevents toxic substances from titanium, nitric oxide and nitric oxide from settling in a sample. The TiN increase in Si can achieve maximum cooling at low N2 concentrations.

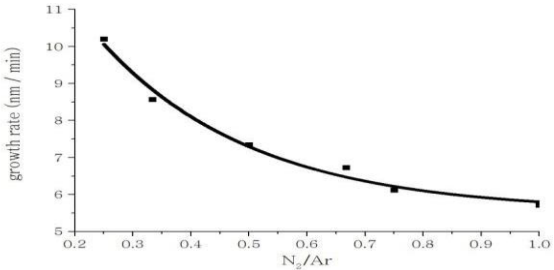

Fig. 1(a): TiN deposition rate Vs Si and N2 / Ar ratio, RF power of 100 W and gas pressure of 2 X10-3 mBar

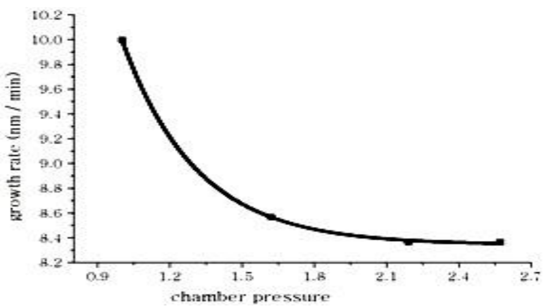

Fig. 1(b): TiN deposition rate on Si, chamber pressure at 100 W power RF and N2 / Ar = 1/3 ratio

Titan metallic and its alloys oxidize immediately in the air. Titanium readily reacts with oxygen at 1,200 ° C (2,190 ° F) in air and at 610 ° C (1,130 ° F) in pure oxygen to form titanium dioxide. However, it is gradual to react with water and air at ambient temperatures because it forms a passive oxide coating that protects the bulk material from additional oxidation. The atmospheric passivation offers a remarkable corrosion resistance of titanium, which almost corresponds to that of platinum. Titan is successful in withstanding attacks from dilute sulfuric and hydrochloric acids, chloride solutions and most natural acids. Titanium is one of the few factors that burn in pure nitrogen gas and reacts at 800 ° C (1,470 ° F) to form titanium nitride, which leads to embrittlement [3-12].

Table 1: Physical properties of TiN

Crystal structure	hexagonal close-packed (hcp)
α	8.5 µm/(m·K) (at 25 °C)
K or λ	21.8 W/(m·K)
ρ	418 nΩ·m (at 20 °C)
E	117 GPa
G	45 GPa
K	110 GPa
µ or 1/m	0.31
Mohs hardness	5.9
HV	829–3421 MPa
RB	715–2772 MPa
CAS Number	7440-32-6

Experimental

Sample preparation

The TiN coating was stored on silicon and low carbon Metal replacement using scattered RF magnetron sputtering structure (13.56 MHz). The objective lens is made of pure titanium (purity: 99.99%, diameter = 25 mm) and is fitted with 5-bit Reinst 1018 steel. The arrangement of the TiN target was about 50:50 with Ar (99.99990%) as active gas and N_2 (99.99990%) as reactive gas. Ar (30 sccm) and N_2 (15 sccm) were injected into the living room with continuous gas. The steps of argon and nitrogen flow are independently managed by large flow flow managers. The modified material was technically purified using ultrasonic 3 CH 2) 2 CO, methanol, HF (silicon chains). Negative voltage was rated at 0, 20 and 60 V and RF power 100 W [1-3]. Substrates are not warm in all analyses. Prior to the certification process, the weight in the chamber was reduced to 1.5 x 10^{-1} bar & Estimated. The deposited films were carried out lasted one hour [26].

Table 2: Sputtering prerequisites used to deposit TiN-Low carbon metal coatings

Deposition parameters	
Argon flow rate	30 sccm
Nitrogen partial pressure	15 sccm
Deposition power (RF)	100 W
Deposition Times (mins)	60 min
Target	Ti(99.99%)
Chamber pressure	1.5 x 10^{-1} bar
Termperature	RT,200°C,400°C,600°C

Characterization methods

These x-rays produced the use of a filtered cathode ray tube for generating monochromatic radiation, collimated, concentrated and directed to a sample. If the prerequisites satisfy Bragg's law ($n\lambda = 2d \sin\theta$), the interaction of the incident beam with the pattern creates positive interference (and diffracted rays) [4-6]. This regulation Connects electromagnetic radiation waves with subtraction perspective and the connection distance the gratings in the crystal pattern by XRD evaluation in Siemens 8D using CuKα radiation (λ = 0.1518 nm). All electrochemical tests are carried out at room temperature with stirring in a 3.5% by weight aqueous NaCl solution, taking into account the corrosion behavior of the substrate and the coating. The standard ASTM B117 salt spray (fog) test consists of spraying a saline solution in uniform droplets onto a sample supported or suspended in a range of 15 to 30 ° from the vertical. The salt response is a 5% (by weight) solution of two NaCl (more than seawater, only up to 1.8% to 3%). The exposed area of the salt spray chamber is kept at 35 ° C. As soon as the pH of the salt reaction is atomized at 35 ° C, will bring the pH range of the collected solution to 6.5 to 7.2. The test is continuous for the duration of the test. The duration of the exhibition is agreed between the customer and the seller at the same time. AFM works by measuring the pressure between the probe and the sample. Typically, the probe is a pyramid with a pointed tip, a tip radius of 15-40 nm and a height of 3-6 µm [16]. The AFM resolution is low (~ 30 nm) for reversal, but the linear resolution can be 0.1 nm. To capture the resolution of the image, AFM generally uses a cantilever to protect it in a vertical and lateral direction. Lever reflects the laser beam with an increase.

RESULT AND DISCUSSION

When performing reactive sputtering deposition at steady state, the model reliably describes the traditional aspects of the process. Hysteresis loop, how deposition parameters (geometry, physics, chemistry) affect width. Hysteresis area can be used. The Berg model assumes that the target current is constant and only the reaction between the gas molecules and the surface occurs with the help of chemisorptions. Recent papers ion implantation has shown an important role in reactive sputtering, but chemisorptions are the primary reaction Mechanism, in particular for gas and reactive metals currents exceed chemical reactivity. Seems to have an XRD evaluation was performed to control the stoichiometry of the thin film [11, 14].

From the graph, determine I = f (2θ) (I am the depth of the diffracted X-rays, 2θ is a perspective view between the X-ray source, substrate and detector), determine Bragg's law of the distance between Shelby Atomic lattice plane:

$$d_{hkl} = \frac{n\lambda}{2 \sin \theta}$$

(Where λ is the wavelength of the X-ray source. In this case, there is a copper tube with θ of 1.54056Å). Since TiNx crystallizes to 0.605≤ x ≤0.999 in a FCC system, it is possible to calculate a regular grid for all sediment. Figure 2 (a) shows the effects of X-ray diffraction evaluation of the deposited TiN film as characteristics of Substrate deformation and pressure during deposition [9-13]. The pattern exhibits a sharp peaks at 2θ range =20-90° which is the characteristics of the TiN phase Cu_2S, FWHM=0.1671 in the density of 5.7900 g/cm^{3}at 600°C.

The XRD pattern showed in Figure 2 (b) shows different directions of cubic (fcc) TiN. Monoclinic (low carbon steel) and tetragonal in (100), (111), (200), (110), and (311) planes. As the bias voltage increases, the proportion of hcp low carbon metal parts decreases or disappears. This determines the single phase fcc shape and indicates the desired (111) orientation. Table 2 suggests the effects of structural tensions of a TiN / low carbon film [23-25]. The presence of tetragonal ($Ca_2Eu_{12}Mn\ Sb_{11}$) carbon can only be identified at 400 ° C, and for FWHM = 0.2005 and the required orientation is (100), ρ= 6.5800 g / cm^3. In fact, at 30 mTorr, the hcp-AlN segment is not displayed, but only the fccAlN structure is detected. The resulting crystal faces are (111), (200) and (311). At 200 ° C ($Ag_{0.2}\ Bi_{1.34}\ Cu_{7.09}\ Pb_{1.37}\ S_{22}$) and FWHM = 0.2674, the TiN thin film crystallizes in a (111) cubic structure at ρ=6.69700 g/cm^3 calculated lattice parameter of a=17.5850Å, b=3.9386 Å, c=28.4530 Å, β=105.410 Å [19-22].

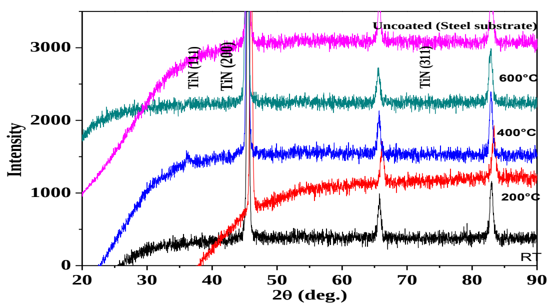

Fig. 2: (a) X-ray diffraction pattern low carbon steel-TiN coating

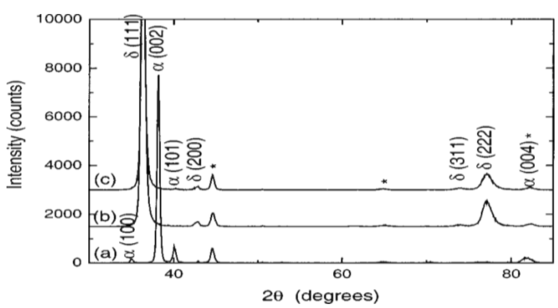

Fig. 2: (b) XRD patterns introduced in depicts exceptional orientations

Hardness, the ratio between E and –ve bias, hardness increased from 13.05 GPa to 20.21 GPa at 100 W, and Young's modulus increased from 170 GPa to 200.79 GPa at 100 W. The hardness values are 20.21 GPa at 600°C, 12.12 Gpa at room temperature, 14.85 Gpa at 200°C, and Young's modulus at 200°C (200.79 GPa) at 400°C (13.29 Gpa) 175 GPa at room temperature and 183 GPa at 180°, 400°C and 184 Gpa [13]. As pressure increases, resistance and modulus deficiency. In fact the stiffness and structural integrity of the softener (E) is strongly influenced by membrane structure and material size.

AFM imaging was used to sample three TiN-covered samples at room temperature, 400°C and 600°C at 40nm, 60nm and 40nm, respectively. One scan was performed on the sputtered TiN in half-contact mode, and its surface scan area was 5 μm x 5 μm. Image from atomic force microscope (refer Fig. 3, Fig. 4, and Fig. 5 titanium the surface has a standard deviation of 55.6423 nm, 42.3304 nm and 23.1762 nm for room temperature coats, 400°C and 600°C respectively [16]. With the results obtained, it can be determined that due to the low frequency there will be a reduction in the cumulative effects of collisions.

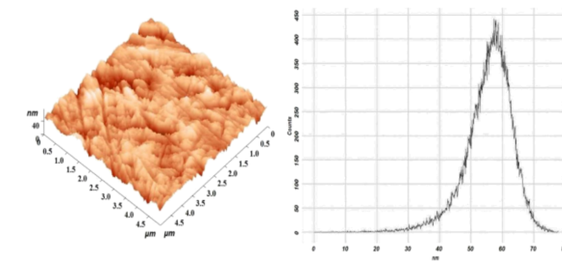

Fig. 3: 5μm × 5μm 3D Image of Sample Coated At 200°C

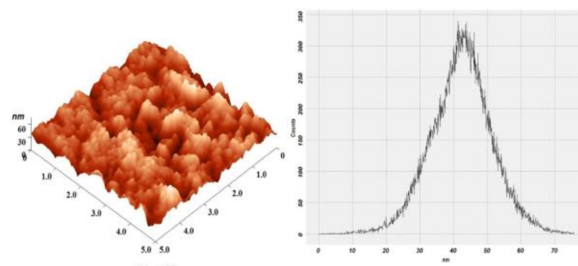

Fig. 4: 5μm × 5μm 3D Image of Sample Coated At 400°C

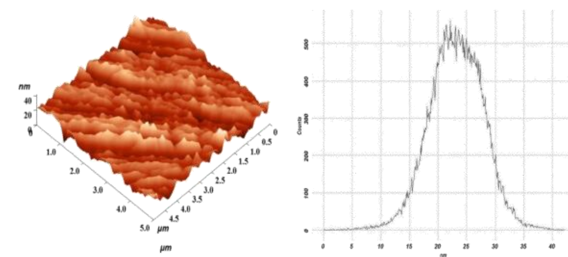

Fig. 5: 5μm × 5μm 3D Image of Sample Coated At 600°C

The microstructure of the TiN film was once arranged for using SEM micrographs. Figure 6 (a, b, c, d) shows high viscosity and microemulsion SEM in the composite section TiN / low carbon metal film, respectively [11, 17]. As shown in Figure 2, the coating was cylindrical and its thickness was estimated to be about 10 μm. 6. (d), the coating is particularly dense. In addition to the presence of large particles, sputter coatings usually have a columnar structure and a smooth shape, especially conventional sputter coatings. The average sized TiN was determined to be 8.3nm (20.0Kv).

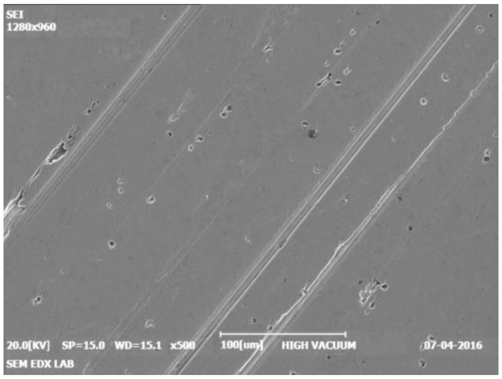

Fig. 6: a Room Temperature

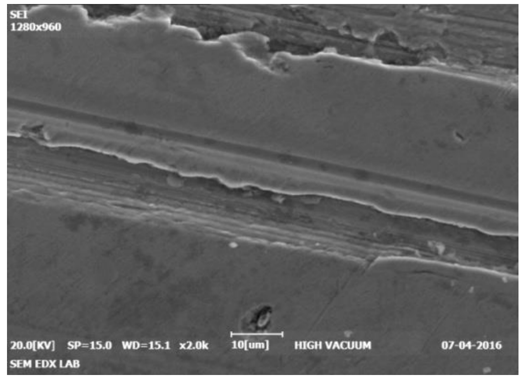

Fig. 6: b 200°C

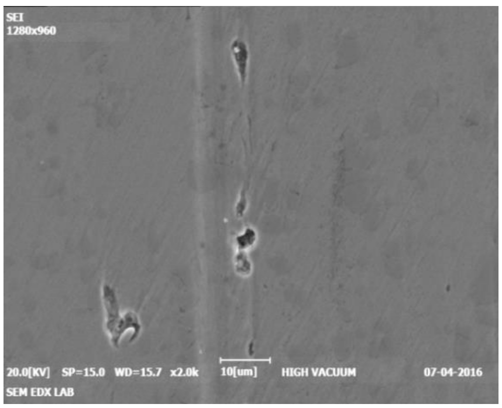

Fig. 6: c 400°C

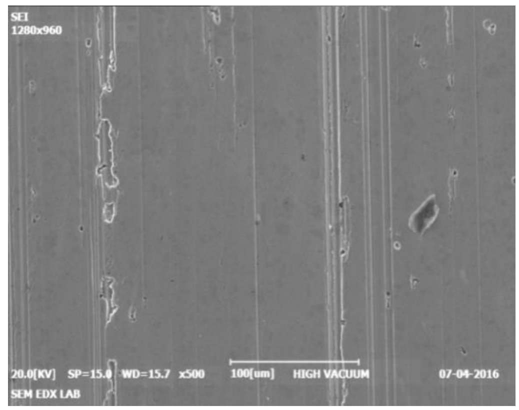

Fig. 6: d 600°C

Figure 6: SEM image of a 10 µm TiN film on low-carbon metal, sputtered with 100 W RF power and 1/3 N_2 / Ar gas ratio

The samples coated with TiN where 12 hours in the salt spray test. The caution for sodium chloride was 5.2% NaCl and the temperature in the chamber was between 34.1 ° C and 35.6 ° C [18]. The pH of the saline solution was 6.9 and the pressure was 15 psi. After a 12-hour salt spray test it was found that no corrosion occurred. From the information obtained it can be concluded that the corrosion resistance of low carbon metals has improved. Where the substrate reacts electrochemically. Adding low carbon metals to TiN can improve consumption barriers.

CONCLUSION

TiN/AISI 1018 coating is successfully deposited by RF magnetron sputtering. According to XRD analysis, the tetragonal shapes were in excess and were observed only under pressure. On the other hand, it was found that when the pretension increased and the elongation decreased, both the hardness and the elastic modulus increased. In this article you have to infer hardness and module methods can achieve ideal values by increasing the preload and minimum pressure. In addition, the TiN coating has Uniform and light column structure. Substrates are well known for electrochemical testing TiN / 1018 coating exhibit excellent corrosion resistance.

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