EFFECT OF RF-SPUTTERING POWER ON PLASMA PARAMETERS AND OPTICAL PROPERTIES OF TiN COATING

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The TiN surface layer depostion by RF- sputtering of Titanium sheet and N2 gas has been proposed two modification Ti6Al4V alloy under the different power of the experimental 50, 100, 150 and 200 watts which is used on the implant bone. The TiN layer is very important for surface modification, according to the diagnosis of these materials through the first spectroscopy which is appear different coulors TiN layer with increase of thickness at different power , cross section FESEM and EDS. the results display the materials peaks comparing with the protective TiN standard andthe spectral absorption and transmission of different power for Ti multi-layer and shows the wavelength of absorption and transmission with range (330- 340 nm), depending on the different count capacity and pure titanium attendance is less peak in less energy and the peak is greater than after the power is greater in (100, 150 and 200)Watt . The microstructural of FIB images display that the coating interlayer is completely bonded to the substrate coating interface and by EDX presented that the coating contains a TiN phase consisting of the coated Ti-6Al-4V surface, as predicted. When RF- sputtering power and RF–sputtering Vbi are increased, resulted in denser surfaces.

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Keywords: Sputtering, implant, FESEM Crosse section, EDS, Surface modification and power

1. Introduction

It has been investigated Ti6Al4V to produce artificial hip joints because of its corrosion resistance, high mechanical strength, toughness, and comparatively low density. [1,2] Though, pure Ti6Al4V has deprived hardness and displays excessive uniform, when showing to the violent body environment.[3,4,5]. However, other surgical alloys have shown better corrosion properties and adhesives than Titanium alloys. [6] Thus, since its introduction in the early 1950s [7, 8], Ti6Al4V became the best Titanium alloy. About 50% of the world's total Titanium production is covered by the Ti6Al4V alloy [7]. Now it is widely used in automotive, aerospace, chemical, marine and biomedical industries [9, 10, and 8]. The main disadvantage of alloys - stand up from the nature of poor-Ti tribological properties, for example, the high and unstable friction coefficient [11], the low corrosion resistance of abrasive materials and adhesives [11, 12.,13,14,15].

2. Experimental part

Ti-6Al-4V alloy samples were used in plasma sputtering (3 x 10 x 10) mm using a diamond cutter (Struers, Denmark). Ti-6Al-4V alloys were manufactured by grinding and mirror polishing respectively, using the Struers-RotoPol-21 system, Denmark. The samples were grinded by SiC sheet in the flowing steps: (120, 180, 240, 320, 500, 600, 800, 1000 and 1200μm of grain size). Samples polished with DP-suspension for (15, 9, 6, 3.1μm) and the use of cloth ports from the same company. The exact polishing of the samples was made using the same device with

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alumina powder (0.51µm) and red DP-Lubricant. Polished samples were, clean acetone-Acetylchloroethyl -acetone solution. The diluted samples were washed with deionized water, dried and stored in a dissociator above the silica gel pad and were used for plasma treatments, microscopic development and electrochemical examination. Clean specimens were stored on the sample holder and placed on the cathode plate to disperse the glowing plasma. The system was pumped down to the base pressure (~ 10-4 mbar), Argon gas was introduced into the room. DC discharge of argon fluorescence (argon plasma) was discharged and applied to each sample for one hour. The sample has been cleaned with a break until all the small arcs have disappeared and a uniform glow can be seen throughout the sample. Plasma treatment of argon was used only as a standard measure to clean the surface of Ti alloy samples, reducing and removing the original oxide and the contaminated layer. Argon gas (Ar) was presented into the evacuated chamber and the flow rate was accustomed until the pressure was steadied at the wanted pressure, and the droplets were cooled in the same gas. Cooling is performed in the same environment mostly to prevent oxidation of samples. The Table (1) show the condition plasma RF – sputtering with different power plasma of Ti-6Al-4V alloy were treated under pressure N2 with (1-3mbar). The case of plasma RF-sputtering in the table (1) and Figure (1) show the coating Titanium layer on samples. The spectral plasma diagnostic, absorption, transmission by spectrometer device SV2100 (Kmac, Korea) and FESEM cross section and EDX by Hitachi (S-4160) scanning electron microscope the magnification power continuous form 6x to 100,000x.

Table 1: The condition plasma Rf – sputtering with different power.

Material	Pressure 1 Torr	Pressure 2 Torr	Load (power) W	Density kg/cm^3	Temperature C°	Time coating Hours
Ti	8.2×10^{-5}	1.3×10^{-2}	50	4.5	Room temperature	1h
Ti	510×10^{-5}	2.47×10^{-2}	100	4.5	Room temperature	1h
Ti	3×10^{-5}	2.19×10^{-2}	150	4.5	Room temperature	1h
Ti	1×10^{-5}	1×10^{-2}	200	4.5	Room temperature	1h

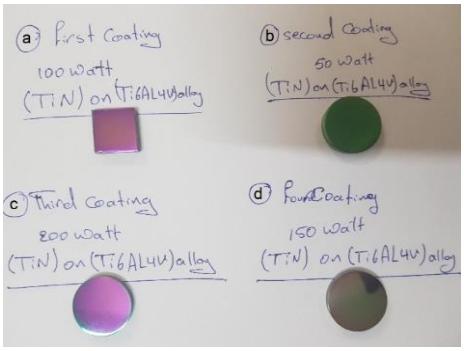


Fig. 1 Image of Ti coating layer on the Ti6Al4V alloy with N_2 gas by different power: a(TiN Of 50Watt), b ((TiN Of 100Watt) , c (TiN Of 150Watt) ,d (TiN Of 200Watt) .

3. Result and discussion

Optical Characteristics

The photographs of pure Ti thin layer deposited on Titanium alloys arranged by RF magnetite are shown in Figures. 2. Ti-4 films showed different colors such as (a) medium orchid, (b) dark green (c) medium blue and (d) goldenrod dark, which were manufactured at constant times different deposition power for 50, 100, 150 and 200 watts Correspondingly. The colors in

Fig. 6a, b, c and d expressed with the maximum reflection curve in the noticeable wavelength range of Ti multi-layer with color peak position. Figures 3, 4, and 5 signify the spectral absorption and transmission of different power for Ti multi-layer and shows the wavelength of absorption and transmission with range (330- 340 nm), depending on the different count capacity.

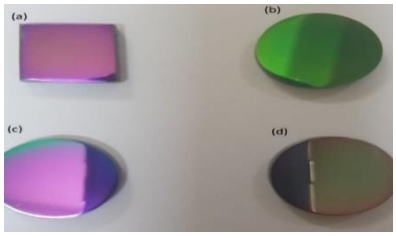


Fig. 2 Titanium multi-layer on the Ti-6Al-4V alloy with different power a(TiN Of 50Watt), b ((TiN Of 100Watt), c (TiN Of 150Watt) ,d (TiN Of 200Watt).

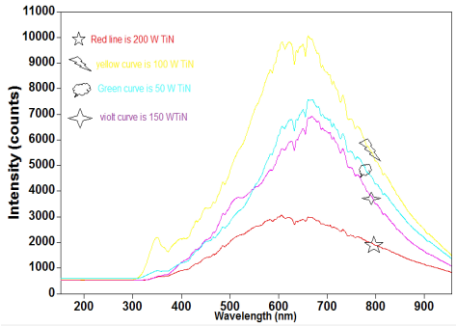


Fig. 3 Overlay Uv-visible spectrum for TiN with different power (50,100,150,200) Watt

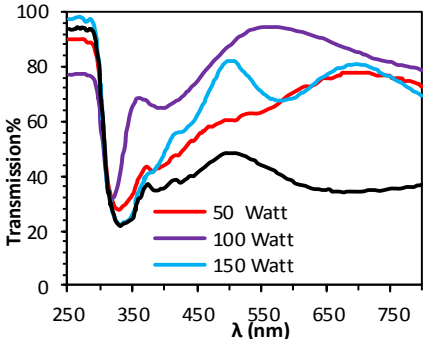


Fig. 4 Overlay Transmission spectral for TiN with different power (50,100,150,200) Watt

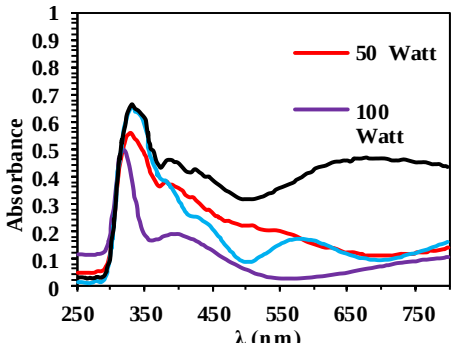
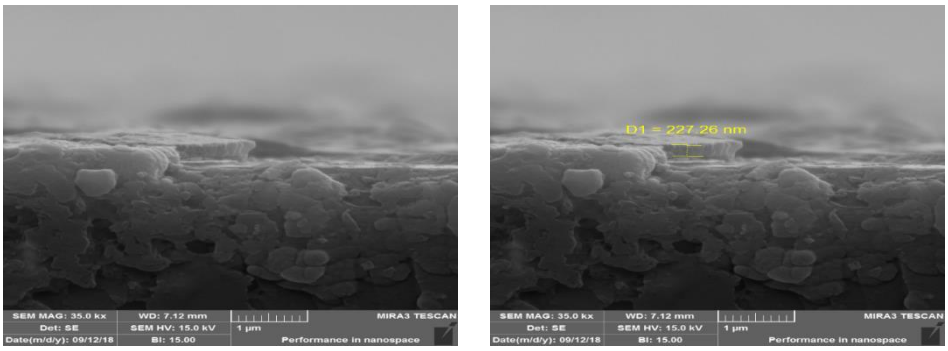


Fig. 5 Overlay Absorption spectral for TiN with different power (50,100,150,200) Watt

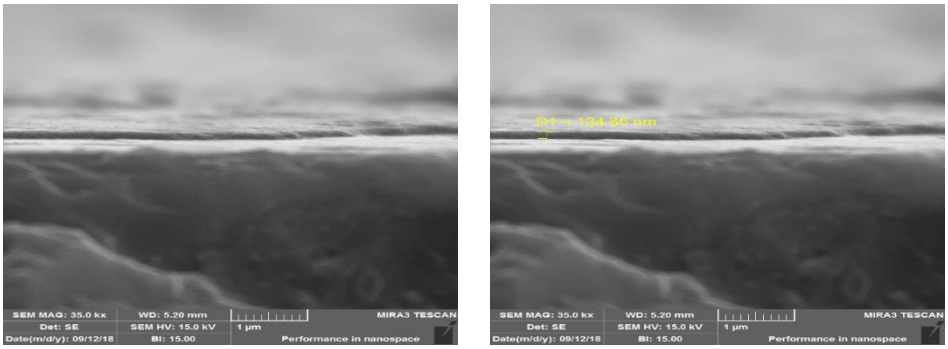
FESEM - Cross Section

The cross sectional display along with the Ti / TiN coating appears in Figure (7, 8, 9, 10).The paint structure was found to be compact and homogenous and could be caused by a dense nucleus from the nucleus of precipitating material to sediment. So as to get a clear view of the microscopic structure of the coating, It was used the focused ion beam technology (FIB). FIB images display that the coating interlayer is completely bonded to the substrate coating interface. As it is seen in Figure 6, 7, 8 and 9 the top layer TiN has a vertical structure and the results in a good agreement with Dobrzański et al [16].



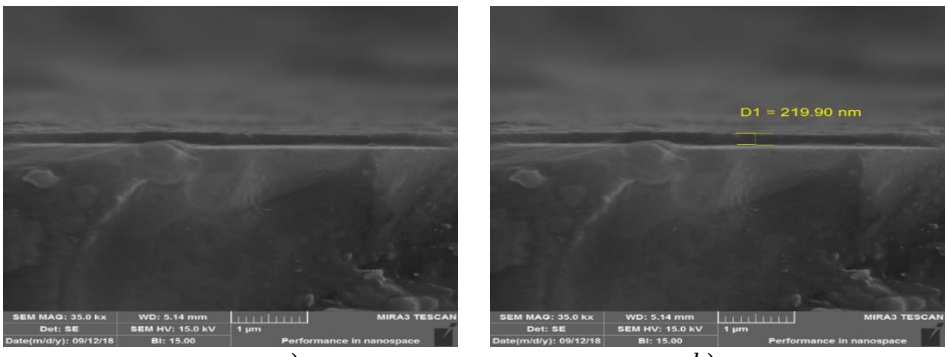
a) *b)*

Fig. 6 Sample 1 layer coating (TiN) on the substrate Ti6Al4V in the (50W) power
a) TiN layer; b) Thickness of TiN layer



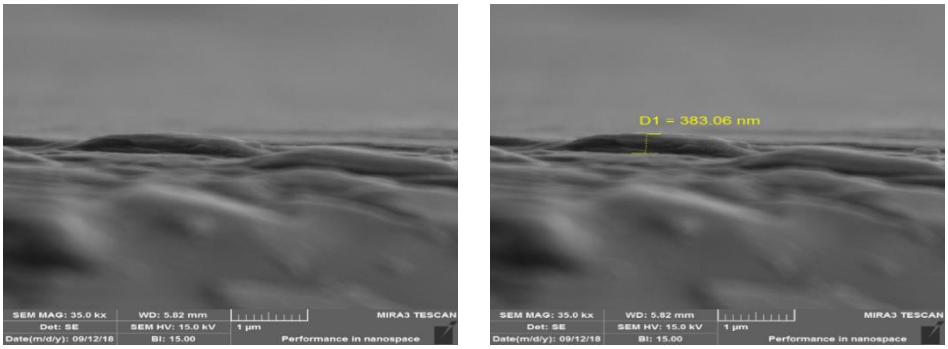
a) *b)*

Fig. 7 Sample 2 layer coating (TiN) on the substrate Ti6Al4V in the (100W) power
a) TiN layer; b) Thickness of TiN layer



a) *b)*

Fig. 8 Show sample 3 layer coating (TiN) on the substrate Ti6Al4V in the (150w)
a) TiN layer; b) Thickness of TiN layer



a) *b)*

Fig. 9 Sample 4 layer coating (TiN) on the substrate Ti6Al4V in the (200w)
a) TiN layer; b) Thickness of TiN layer

Plasma spectral diagnostic

The identification of the substance by the plasma spectrum is very significant for determining the used material and the actual rations of the material in the coating layer. In Figure (10), a comparison of the material and experimental coating parameters obtained by the spectrophotometer was shown by looking at exactly the used materials in the Figure (14) Diverse types of materials (argon gas, Titanium sheet by radio frequency spectrum). In diagnostic spectral the sheet Titanium attendance a low energy peak at 50 Watt compared with high peak energy at the power at 100, 150 and 200 watt.

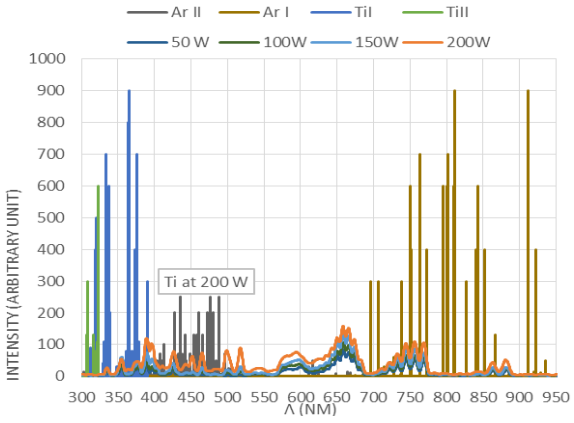


Fig. 10. Shows the samples (1, 2, 3 and 4) for spectral plasma diagnostic with different power.

EDS (Energy Dispersive Spectroscopy)

Figure 11 shows the chemical arrangements of different coatings layers with their bulk substrates gained by EDX cross-sectional scanning procedure. The EDX measurements demonstrate the deposition of the intended material. The results of the EDS analysis in Table (3, 4, 5 and 6) presented that the coating contains a TiN phase consisting of the coated Ti-6Al-4V surface, as predicted. When RF- sputtering power and RF–sputtering V_{bi} are increased, resulted in denser surfaces, as it is seen in Fig. 11, 12, 13 and 14, it can be noticed that coating with a higher RF-sputtering bias voltage makes the surface thicker comparing with the low RF-sputtering **.**

Table (3). Show the specific component of layer coating (TiN) for sample 1 in the (50W) power.

Element	Line Type	Apparent Concentration	k Ratio	Wt%	Wt% Sigma	Atomic %	Standard Label	Factory Standard
N	K series	52.01	0.09260	88.52	0.45	96.35	BN	Yes
Ti	K series	1.00	0.00999	11.48	0.45	3.65	Ti	Yes
Total:				100.00		100.00		

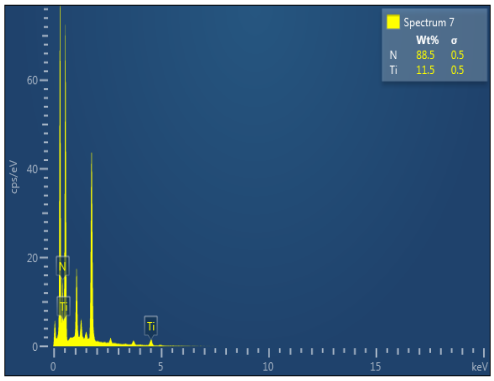


Fig. 11 The peak of the component coating layer (TiN) for sample 1 in the (50W) power.

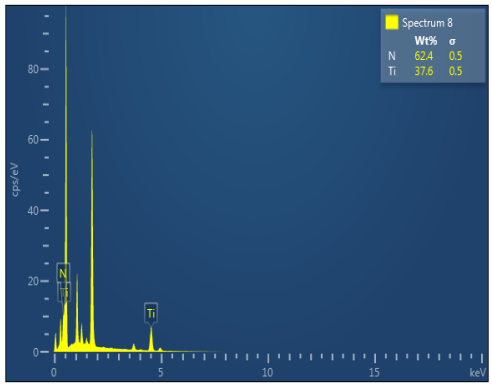


Fig. 12 The peak of the component coating layer (TiN) for sample 2 in the (100W) power

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Table (4) the specific component of layer coating (TiN) for sample 2 in the (100W).

Element	Line Type	Apparent Concentration	k Ratio	Wt%	Wt% Sigma	Atomic %	Standard Label	Factory Standard
N	K series	46.83	0.08338	62.44	0.54	85.04	BN	Yes
Ti	K series	4.87	0.04872	37.56	0.54	14.96	Ti	Yes
Total:				100.00		100.00		

Table (5). The component of layer coating (TiN) for sample 3 in the (150W) power.

Element	Line Type	Apparent Concentration	k Ratio	Wt%	Wt% Sigma	Atomic %	Standard Label	Factory Standard
N	K series	24.18	0.04305	27.72	0.55	56.74	BN	Yes
Ti	K series	13.27	0.13274	72.28	0.55	43.26	Ti	Yes
Total:				100.00		100.00		

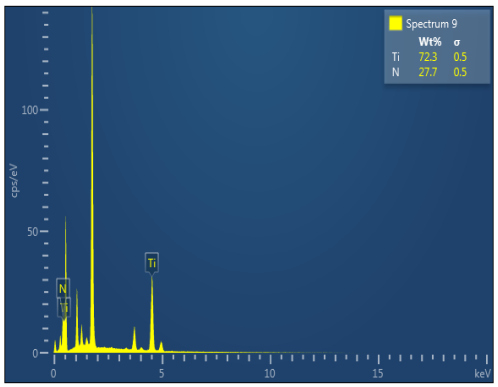

Fig. 13 The peak of the component coating layer (TiN) for sample 3 in the (150W) power.
Table (6) The component of layer coating (TiN) for sample 4 in the (200W) power.

Element	Line Type	Apparent Concentration	k Ratio	Wt%	Wt% Sigma	Atomic %	Standard Label	Factory Standard
N	K series	24.67	0.04392	31.75	0.56	61.40	BN	Yes
Ti	K series	10.92	0.10915	68.25	0.56	38.60	Ti	Yes
Total:				100.00		100.00		

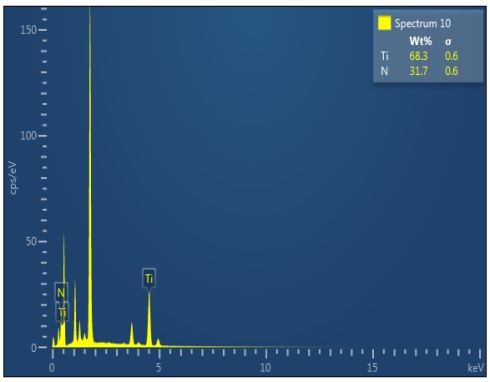

Fig. 14 Show the peak of the component coating layer (TiN) for sample 4 in the (200W) power.

4. Conclusions

In this work the optimization of surface modification show in the power load 200W by during make the diagnostic plasma spectral this is see in the image of FESEM the high thickness of layer coating this behaviour given the good surface modification for alloy and the result of EDX test shown in all image the peak of TiN(titanium nitraiding) mean find the layer from Ti in the surface this thin from TiN allow growth the compatibility between alloy and tissueand and good optical properties this is show in the different coating colours image on the surface alloys.

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