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An investigation about image and voltage profile of Titanium Nano layer

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ABSTRACT

Titanium thin films were deposited on glass substrates with the thickness of 40 nm. The layers are produced with physical vapor deposition method (heat evaporation), under high-vacuum condition. The nano-structures of the films were obtained, using X-ray diffraction (XRD), and atomic force microscopy (AFM) methods. image profile and voltage diagram of nano layers were obtained titanium grains have nano metric height and a continues voltage on layer.

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INTRODUCTION

Because of good mechanical properties, a very high strength, excellent corrosion resistance and good biocompatibility titanium has attracted considerable interest in several industries, such as aerospace engineering, chemical processes and medical industries (Ortega *et al*., 2008, Song *et al*., 2007). In the last few years nanostructured materials have attracted a great attention which is because of their unique characteristics (Borah *et al*., 2008). Films of titanium are widely used as coatings in various technical units, as absorbers of gases in high-vacuum pumps, etc. (Lendel *et al*., 2010). Film composition, microstructure and density are very much dependent on preparation methods and conditions (Xie *et al*., 2008). Pure titanium is a highly reactive metal and is mostly protected by TiO2 which is very stable (Ortega *et al*., 2008). Titanium oxide is one of the transparent conductive oxides. The oxide films are stable and strongly adherent to the substrate (Igwe *et al*., 2010). Titanium Dioxide is used extensively in thin film optical-interference coatings (Diebold, 2003).

Experimental details:

Titanium nano-layers were deposited on glass substrates (18× 18 × 1 mm, cut from microscope slide) by using resistive evaporation method, from tungsten boats, at room temperature. The evaporated materials were pieces of Titanium with 98% purity. An ETS160 (Vacuum Evaporation System) coating plant with a base pressure of 10^{-6} mbar was used. Prior to deposition, glass substrates were ultrasonically cleaned in heated acetone first and then in ethanol. The substrate holder was a disk of 36.5 cm in diameter with adjustable height up to 45 cm and also adjustable holders for placing any kind of substrates. Thicknesses of layers were determined by quartz crystal microbalance technique. Thickness of layers obtained 40 nm. The structure of these films were studied by using a Philips XRD X'pert MPD Diffractometer (CuK_α radiation) with a step size of 0.03 and count time of 1s per step, while the surface physical morphology and roughness was obtained by means of AFM (Dual Scope ^{TM} DS 95-200/50) analysis.

RESULTS AND DISCUSSIONS

Figure 1 shows, Two dimensional AFM image of 40 nm titanium on glass substrate produced inthis work. As it can be seen surface is full of tiny Ti grains. Fiuger 2 shows, Tree demensional AFM image of Ti/glass with 40 nm thickness produced in this work. In agreement with figure 1, surface is full of needle like grains with a lot of voids between them.

Figures 3 and 4 show, two and three dimensional phase picture for titanium on glass with 40 nm thickness respectively. As it can be seen from these two figures, there are different colors for different places on surface that shows produced layer is not homogeneous and that is obvious because of nano metric thickness of layer.

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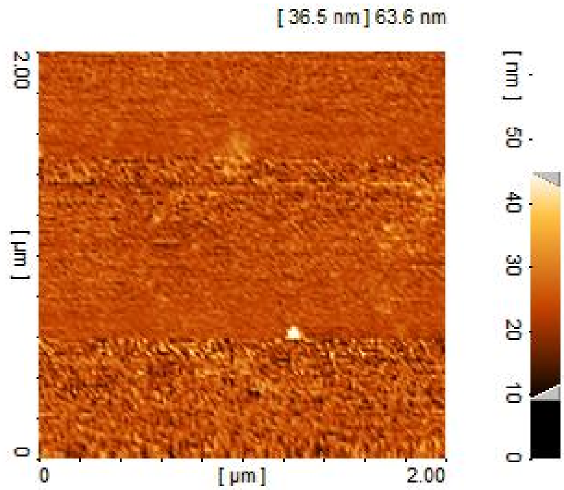

Fig. 1: Two dimensional AFM image of Ti/glass.

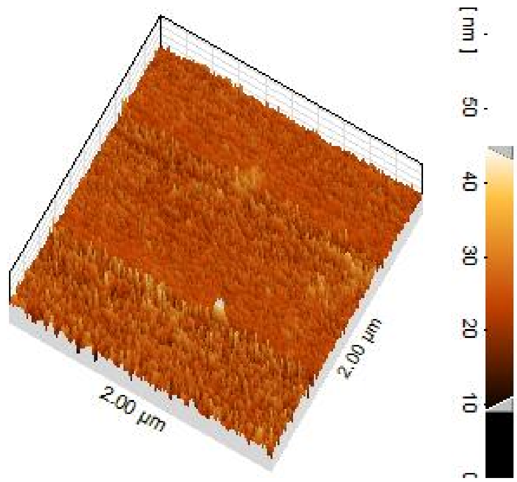

Fig. 2: Tree dimensional AFM image of Ti/glass.

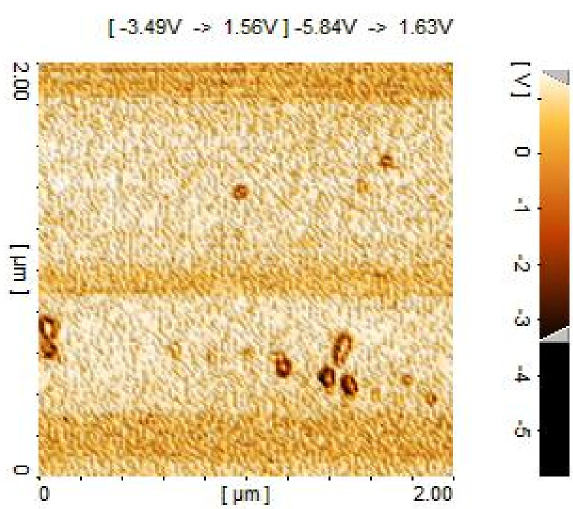

Fig. 3: Two dimensional phase image of Ti/glass.

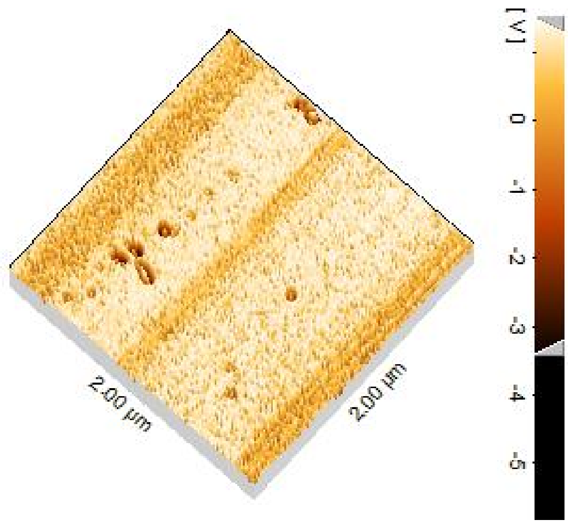

Fig. 4: Tree dimensional phase image of Ti/glass.

Figure 5 shows, two dimensional AFM image along with identified oblique arrow for Ti/glass nano layer. as it can be seen from figure 5, this arrow contains Titanium grains also voids and substrate atoms. Figure 6 shows image profile of identified oblique arrow in figure 5. Ti needle like grains with about 30 nm height in average along with voids are clear from figure 6.

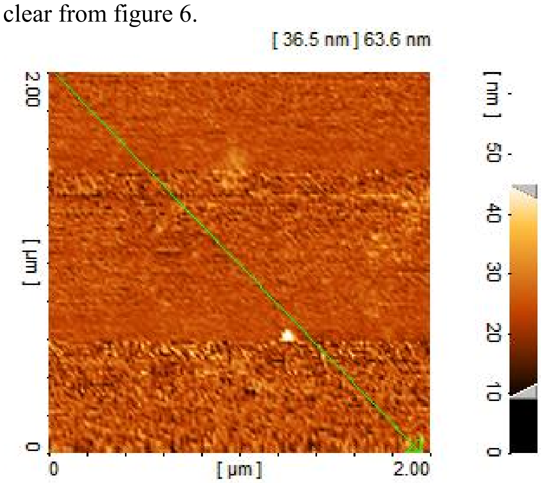

Fig. 5: Two dimensional AFM image of Ti/glass with identified oblique length.

Fig. 6: Image profile of oblique length.

Figure 7 shows two dimensional phase image of Ti/glass nano layer produced in this work with exactly the same identified arrow as figure 5 to obtain the voltage along this arrow. Figure 8 shows, the voltage diagram for identified oblique length in figure 7. As it can be seen there is a continues voltage at about o.5 V for the grains in this length and zero volt for voids.

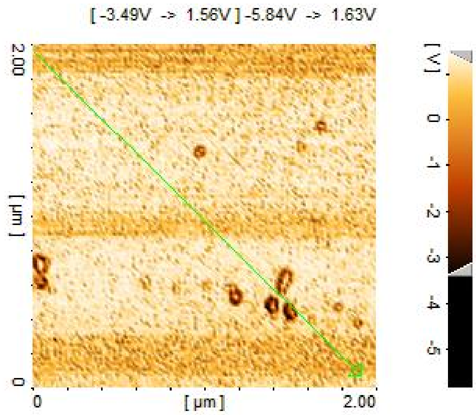

Fig. 7: Two dimensional phase image of Ti/glass with identified oblique length.

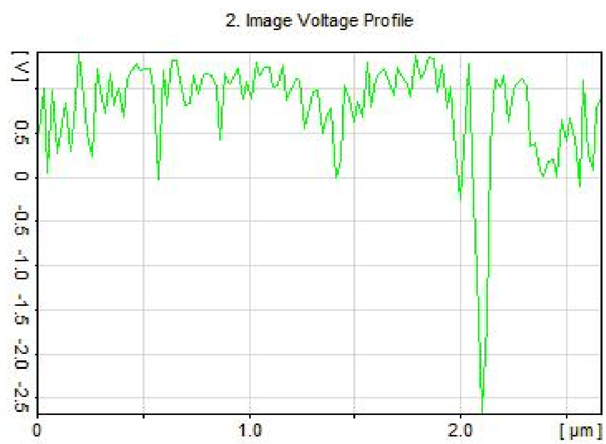

Fig. 8: Image voltage profile of identified oblique length.

Figure 9 shows the X-ray diffraction pattern of Ti/glass layer produced in this work. It shows that produced layer is amorphous and a wide peak appear at about 20 to30 degree belongs to glass substrate also noisy pattern is because of amorphous glass substrate.

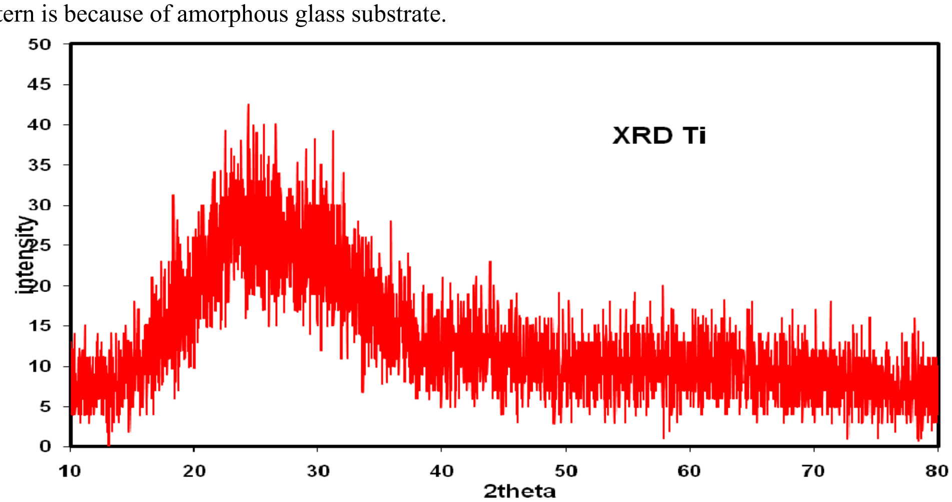

Fig. 9: X-ray diffraction of Ti/glass of 40 nm thickness.

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Conclusion:

Titanium nano layers of 40 nm thickness on glass substrate at room temperature and HV conditions were produced by PVD method. Structural properties, voltage image, grain size and height distribution of produced layers were investigated by AFM method. There are needle like titanium grains on glass substrate with a lot of voids between them. The grain size was nano metric, there were a low and continues value of voltage for produced Ti/glass layer. Crystallographic property were investigated by XRD method. For 40 nm thickness at room temperature Ti/glass layer was amorphous

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