

SURFACE ANALYSES OF TiN THIN FILMS GROWN ON 304 STAINLESS STEEL BY CATHODIC ARC TECHNIQUE

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Titanium nitride thin film has been widely employed in cutting tools to extend their working life and in decorations for its golden color. TiN is an important material in advanced surface protective coating area for steel [1]. Moreover, studies on the TiN properties have solved significant problems, such as the reduction of the usefulness of the TiN films for corrosion resistant coatings and for diffusion barriers in the films [2,3]. The main field of their applications is in the machine industry as refractory materials and as hard and wear resistant films on machine tools and mechanical parts. However, the adherence of TiN films on steel substrate is not well known yet. Nowadays, TiN thin films deposited by plasma vapor deposition have become of great importance due to their increasing use in cutting tools, as a protective coating and decoration [2,4]. The cathodic arc deposition is a useful method to deposit TiN films [4].

TiN films deposited at different substrate temperatures have been produced on the surface of 304 stainless steel with a titanium interlayer by using cathodic arc evaporation deposition process. In this work, the influence of the substrate temperature on the surface morphology of deposited titanium nitride (TiN) films by using a titanium interlayer are presented and discussed. The adherence of titanium films on steel substrate has been demonstrating good adherence results [5-7]. These TiN films were deposited onto the 304 SS at 220°C and 450°C. In this study, TiN thin films were coated using a vacuum arc as a titanium ion source in nitrogen gas. The surface morphology analysis was performed after the deposition process. The surface morphology was investigated by scanning electron microscopy (SEM).

The substrates used for the TiN deposition were 304 SS 3mm thick and 15mm of diameter. They were polished with a sequence of SiC sandpapers down to 1200# grid, polished with 1µm alumina and ultrasonically cleaned for 20 min in acetone bath before being put in the chamber.

The deposition of Ti thin film interlayer and TiN film on 304 SS substrate was carried out by conventional cathodic arc technique. The coating material was Ti (99.95%) and the reactive gas was industrial nitrogen (99.99%). Before the deposition process the substrates were bombarded with Ar ions for 10 min. Titanium thin film with a thickness of 0.1µm approximately were first deposited on polished surfaces of 304 SS substrate. After that, TiN films were deposited on Ti film-304 substrate system by varying the substrate temperature (220°C and 450°C) and keeping the bias voltage (= -80V) and the nitrogen flow rate (= 1200 sccm) constant in this process. Each deposition process was performed at a substrate temperature.

The surface morphology of the samples was observed with JEOL model JSM-5310a attached to an energy dispersive spectrometry (EDS).

Fig. 1a and b shows the surface morphology of TiN growth with two different substrate temperatures (220°C and 450°C). As can be observed in Fig.1a), where TiN thin film are deposited on 304 SS at 220°C, pores and white stains are distributed over the surface and white stains are found to be in a cluster form in the TiN matrix instead of uniform distribution. These white stains have been identified to be incompletely reactive titanium particles [8]. They are unable to form a strong bond in the grain boundary with the TiN matrix. As shown in Fig.1b), where TiN thin film are deposited on 304 SS at 450°C, white stains were partly reduced.

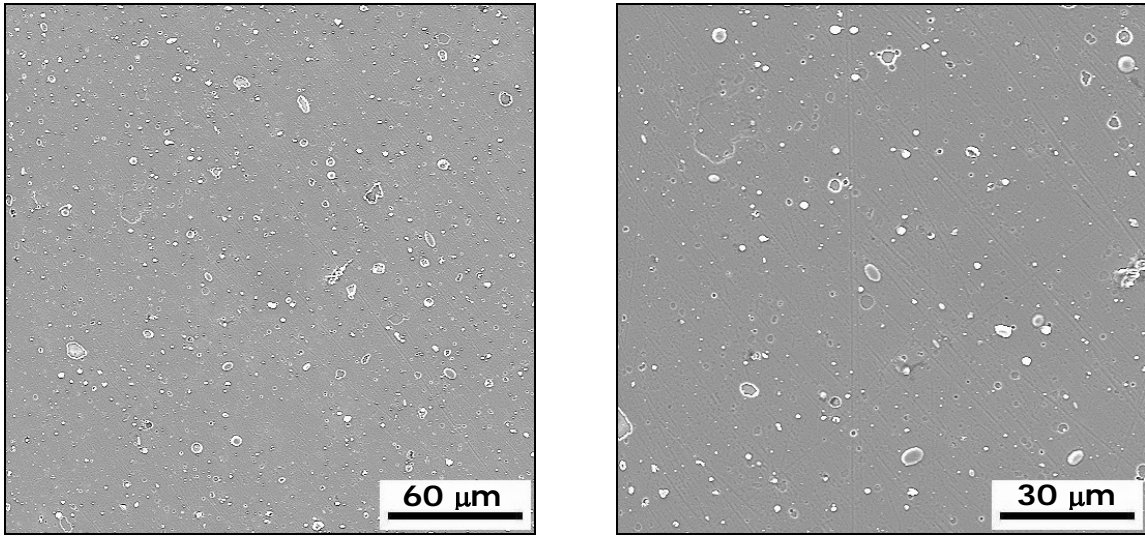
Results show that the surface morphology of the TiN film-Ti film-304 SS substrate system can be improved by increasing the substrate temperature prior to the deposition of the film.

These results suggest that a TiN film growth on a 304 SS substrate by using the conventional cathodic arc technique has potential applications as protective coating and to extend their working life.

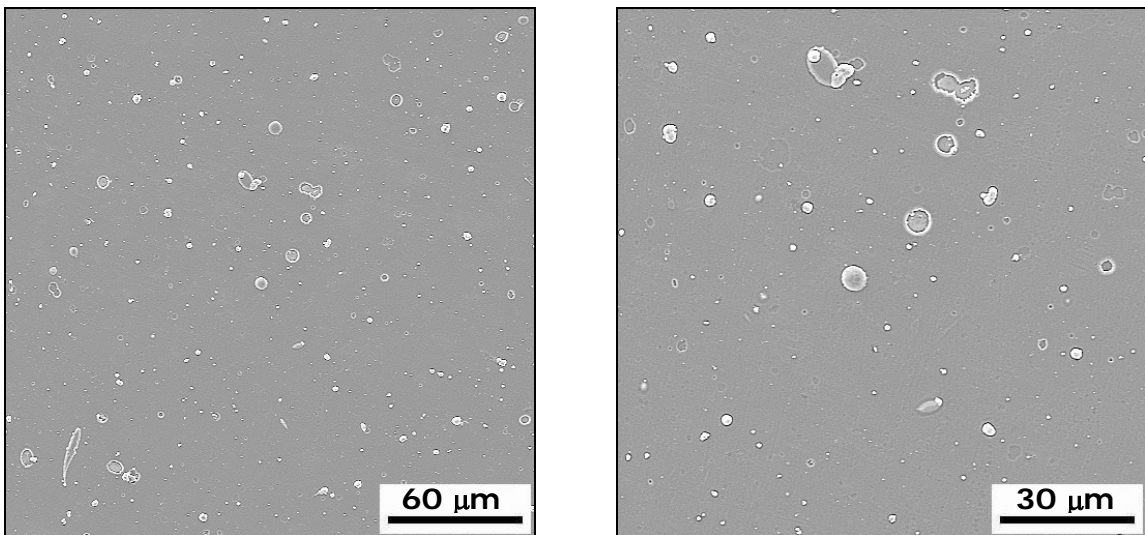
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a)



b)

Figure 1 – Surface morphology obtained by SEM of TiN thin film deposited on 304 SS substrate; a) TiN thin film deposited at 220°C and b) TiN thin film deposited at 450°C