SELF-CLEANING CERAMIC TILES BY DEPOSITION OF AUTOCATALYTIC TIO_2 THIN FILMS USING DC MAGNETRON SPUTTERING

Suzy Pascoali[(1)], Sérgio Artur Bianchini Bilac[(1)], José Octavio Armani Paschoal[(2)], Marcio Celso Fredel[(1)], Orestes Estevam Alarcon[(1).]

[(1)]Programa de Pós-Graduação em Ciência e Engenharia de Materiais
PGMAT/LABMAT/UFSC
[(2)]CCB – Centro Cerâmico do Brasil. Trindade, Florianópolis-SC. Brasil.
orestes@materiais.ufsc.br

ABSTRACT

A DC Magnetron Sputtering equipment was used to coat the surface of ceramic tiles with TiO_2 thin films. Plasma process occurred in an atmosphere of pure oxygen using a 99,5% pure Titanium target. Layers were deposited onto glass and ceramic tiles at room temperature and at 200°C. Different deposition conditions were used to obtain four different films.

1. INTRODUCTION

Self-cleaning tiles can be obtained using photocatalytic and photo-induced superhydrophilic properties of TiO_2. Actually this material is a semiconductor with large band gap, in which a UV photon excites one electron in valence band to conduction band, producing an electron-hole pair. The available electron reacts with oxygen and water vapour adsorbed in surface and creates super oxide radical O_2^-. Superoxide is a very reactive radical strong enough to break down hydrocarbon molecules, after several reactions, in CO_2 and H_2O. Other possibility occurs when the hole reaches surface and reacts with oxygen of structural TiO_2, creating an oxygen vacance at the surface. This vacance reacts with water forming a hydroxyl radical decreasing the surface energy of the layer. Thus, superhydrophilic behaviour occurs when an oxygen bridging is formed at the TiO_2 surface. These sites of oxygen are more likely to occur in anatase crystal than in rutile ones. These properties improve specials functions at the surface such as self-cleaning When an organic molecule reaches the surface of the film super oxide radical brakes it down. An inorganic dust reaching the surface is easily removed latter by wash or rain[1]. In consequence TiO_2 films have been investigated deeply and can be produced by a number of different methods like sol-gel[2], chemical vapour deposition[3] and physical vapour deposition[4]. The last one is known by good coatings stoichiometry, improved adhesion and mechanical stability of the layers.

In this work a magnetron sputtering system was used to produce photocatalytic TiO_2 films onto ceramic tiles and glass. The structure and thickness of films were measured. X-rays diffractogram showed three classes of films. One with a great majority of anatase crystallites, others are mixture of rutile and anatase, and another one almost amorphous.

2. EXPERIMENTAL

TiO_2 thin films were prepared on ceramic tiles and glass by DC Magnetron Sputtering, using pure Ti target (99,5%) in pure O_2 atmosphere. One deposition was made at room temperature and the others at 200^0C. Since atmosphere was of pure oxygen, target was in oxide mode. The deposition time for films formation was 10, 15, 30 and 60 min. Film thickness was measured in transversal section via SEM (Scanning Electron Microscopy). The effect of deposition condition on the crystalline structure was determined by low angle X-rays diffraction (XRD).

3. RESULTS AND DISCUSSION

Layers on ceramic substrate are presented in figure 1 and glass substrate in figure 2. TiO_2 thin films deposited onto ceramic for 15min are 262nm thick, and films deposited for 30 and 60min are 886 and 606nm thick, respectively. Films formed onto glass are 292, 841 and 561nm thick, respectively for 15, 30 and 60min of deposition. Films formation rates were different for each condition of deposition, about 20, 28 and 10nm/min for, respectively 15, 30 and 60min of deposition time. Thicker films were obtained in condition of 30 min. This happened because deposition parameters are different one from the other.

X-Ray Diffractograms are shown on figure 3. Films structure on the same run on glass and ceramic, have almost the same structure for the 15 and 30min run. However,

there were some differences among samples deposited for the 60 min run. Films on glass show anatase peaks, but ceramics sample presents peaks of rutile and one peak at 20^0 corresponding to Ti_3O_5. In tests of 15 and 30 minutes there are two pattern of peaks of anatase and rutile, 2θ of 25, 35 and 48^0 for anatase and 2θ of 27, 38 and 44^0 for rutile. In test of 15min the highest peak is at $2\theta = 27^0$ correlated to (110) of rutile crystal. This is a rich rutile crystalline plane in oxygen bridging[5]. There were no peaks present in test made for 10 min at room temperature.

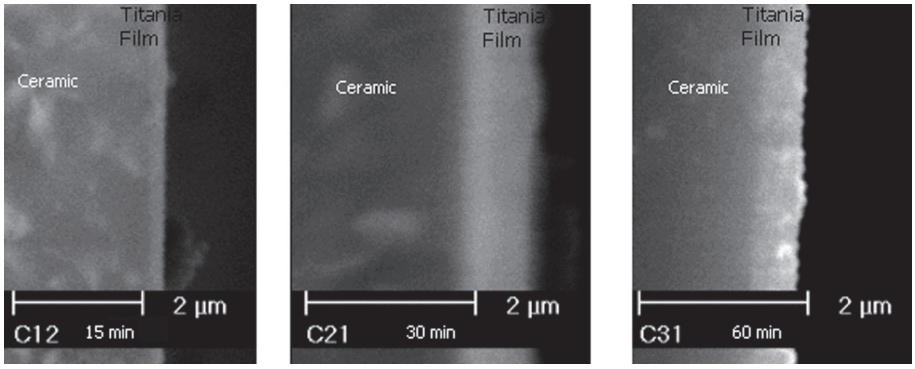


Figure 1. Transversal micrograph of TiO_2 thin films deposited for 15min, 30min and 60min onto ceramic substrate.

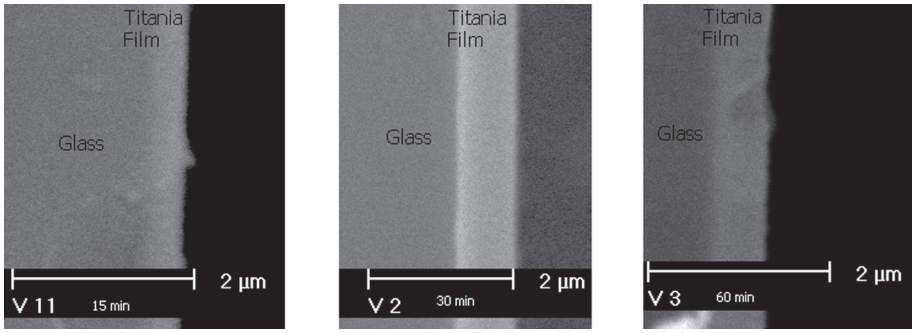
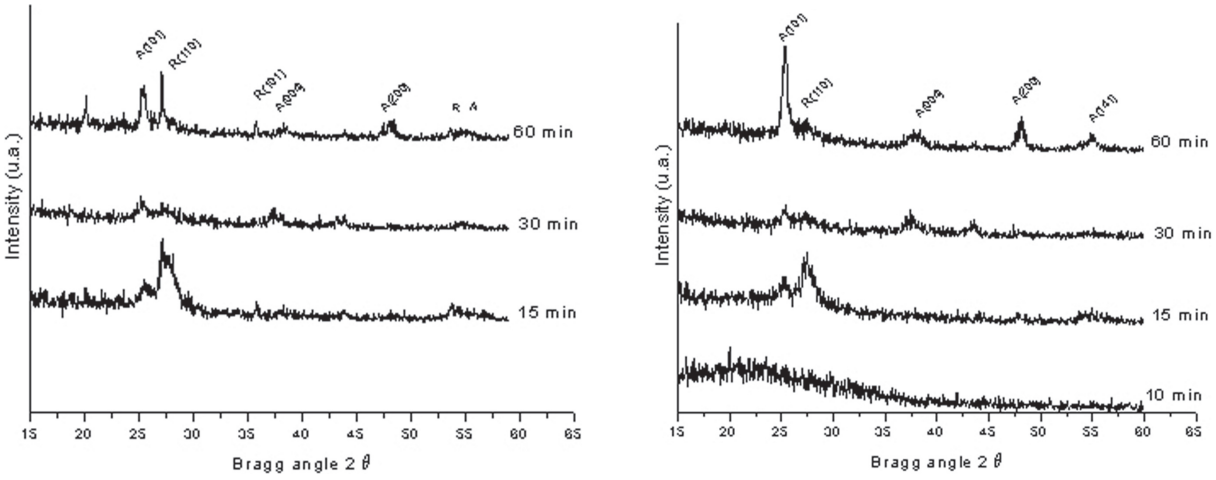


Figure 2. Transversal micrograph of TiO_2 thin films deposited for 15min, 30min and 60min onto glass substrate.



(a) ceramic *(b) glass*

Figure 3 – XRD patterns of TiO_2 thin film by Sputter deposition for 10min, 15min, 30min e 60min onto ceramic (a) and glass (b).

4. CONCLUSION

TiO_2 thin films were deposited from a pure titanium target by DC Magnetron Sputtering. Sputtered films are anatase and rutile.

5. ACKNOWLEDGEMENTS

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