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Wear of TiO_2 thin films deposited on a Ti-6Al-4V alloy via sol-gel technique

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Abstract – TiO_2 films have good haemocompatibility but little information about wear resistance is available in the literature. Then TiO_2 films were generated by the dip-coating sol-gel technique on a Ti-6Al-4V alloy and its wear resistance was measured in a ball-on-flat machine. The influence of the withdrawing velocity, the aging time of sol, the heat treatment temperature and the number of layers on the wear resistance were studied. It was found that higher temperature of heat treatments and multilayer films improve the wear resistance.

TiO_2 thin films have good haemocompatibility properties which made them suitable for coating prosthetic heart valves [1, 2]. Little information about wear resistance of this film is available in the literature, one probable cause maybe its strong related with the fabrication process.

The wear resistance of TiO_2 thin films, fabricated by the sol-gel dip-coating technique, was measured [3-5]. A rotating ball-on-flat device was used in order to approximate the movement of a pivot in a prosthetic heart valve. Lubricated tests were performed, employing a 6.35 mm in diameter glass ball as counterface. A constant 7 rpm and 1 N in load [3-5] were chosen to perform the test; this value exceeds more than 50 times the stress calculated on the valve pivot. Optical microscopy was used to characterize the film before and after the wear test.

The influence on thickness and wear of three dip-coating process parameters: the withdrawing velocity, the sol aging time and the heat treatment temperature, beside the number of layers were studied.

Film thicknesses ranged between 50 to 200 nm were obtained by comparing the films color with the relation between color and thickness reported in the literature [6, 7]. The withdrawing velocity and sol aging time had noticeable influence on the film thickness but it is negligible on the wear resistance. On the other hand, the heat treatment temperature, which produces different crystalline structures [6], and the numbers of layers had large influence on the wear resistance. In the Figure 1, it is shown four wear scars. In Figures 1.a and 1.b, it is observed a wear scar on two monolayer films; the light gray circular scar corresponds to the substrate material. In Figure 1.c, it is observed a circular scar, on a trilayer film, composed of a core and a halo, which are the substrate and the worn film, respectively. In Figure 1.d, it is observed a circular scar, on a trilayer film, composed of a core and a halo, which are a thin worn film and a thick worn film, respectively. The results of this study have shown that higher temperatures of the heat treatments and more layers increased the wear resistance of the films.

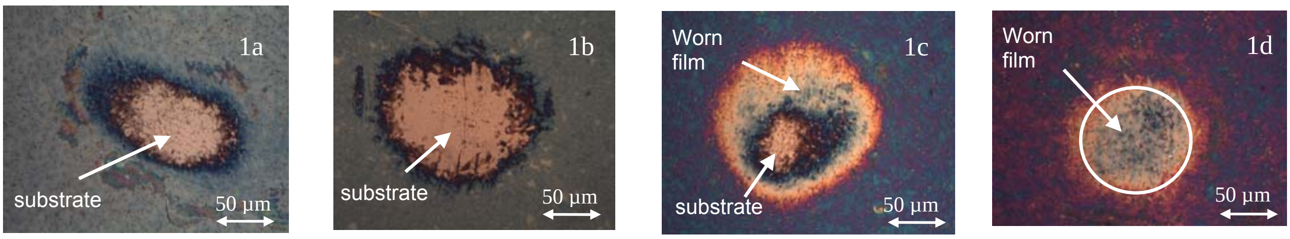

Figure 1. Worn films after a 5 minutes test: **a)** and **b)** are monolayer films; **c)** and **d)** are trilayer films.
These films were obtained using a 2 cm/min withdrawing velocity and thermal treatments at 600ºC for 1h.

References

[1] J. Liu, D. Yang, F. Shi and Y. Cai, Thin Solid Films, 429 (2003) 225-230.
[2] N. Huang, P. Yang, Y. X. Leng, J.Y. Chen, H. Sun, J. Wang, G.J. Wang, P.D. Ding, T.F. Xi and Y. Leng, Biomaterials, 24 (2003) 2177-2187.
[3] B. Surowska, J. Bieniaś, M. Walczak, K. Sangwall and A. Stoch, Applied Surface Science, 238 (2004) 288-294.
[4] W. Zhang, Ch. Wang, W. Liu, Wear 260 (2006) 379–386.
[5] W. Zhang, W. Liu, Y. Liu, Ch. Wang, Ceramics International 35 (2009) 1513–1520.
[6] D. Velten, V. Biehl, F. Aubertin, B. Valeske, W. Possart and J. Breme, Journal Biomed Mater Res, 59 (2002) 18-28.
[7] A.K. Sharma, Thin Solid Films, 208 (1992) 48-54.