Mechanical and adhesion properties of a titanium dioxide film for biomedical applications

Soares, P.; Mikowski, A.; Szesz, E. M. ; Kuromoto, N. K.; Lepienski, C. M.
LabNANO - Depto. Física - UFPR

Due to its singular characteristics, the titanium has been extensively used as dental implants. One of these characteristics is the presence of a natural titanium dioxide layer on its surface. This thin layer is suitable for the cellular growth besides the fact that isolates the metal from the body fluids. Therefore, it is important to study the mechanical properties such as the elastic modulus, hardness, and interface adhesion of the titanium dioxide films. The mechanical properties were studied by depth-sensing indentation techniques using a Nano-Indenter XP system. The hardness and elastic modulus of the titanium dioxide films were measured with a Berkovich, three sided pyramidal diamond indenter, with an 8 complete cycles of loading/unloading and loads ranging from 3.1 to 400 mN. Scratch tests were made using a diamond Berkovich indenter, and a steel spherical indenter (0.1 mm tip diameter). A 1 mm scratching track was applied to all tests with a constant normal load of 400 mN during the scratching. The films were deposited potentiostatically by anodic oxidation, using sulfuric acid as the electrolyte with applied voltage of 150 and 180 V, and platinum as counter-electrode during 60 seconds at room temperature. Atomic force microscopy showed that the film produced with 180 V presents higher roughness than the one produced with 150 V. Nanoindentation and nanoscratch tests revealed that the hardness and modulus of the films increase slightly with voltage. Scanning electron microscopy observations showed that for both deposition conditions, the films have good adhesion strength to the metal substrate. Scratches made with the spherical indenter showed only a slight deformation on the film surface, not allowing us to determine the adhesion force of the films. The Berkovich scratches, starting from the substrate showed that the film is well adhered, presenting no chipping.

Palavras-Chave:

titânio, implantes, nanoindentação, dureza, módulo de elasticidade, risco.