題名:Chemical Modification of Titanium Surface by Glow Discharge

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上傳時間:2009-11-23

摘要:Glow discharge plasma treatment is a frequently used method for cleaning, preparation, and modification of biomaterial and implant surfaces. The merits of such treatments are, however, strongly dependent on the process parameters. In the present work the possibilities, limitations, and risks of plasma treatment for surface preparation of metallic materials are investigated experimentally using titanium as a model system, and also discussed in more general terms. Samples were treated by different low-pressure direct current plasmas and analyzed using Auger electron spectroscopy (AES), x-ray photoelectron spectroscopy (XPS), atomic force microscopy, scanning electron microscopy, and light microscopy. The plasma system is a home-built, ultra-high vacuum-compatible system that allows sample introduction via a load-lock, and precise control of pressure, gas composition and flow rate, etc. This system allows uniform treatment of cylindrical and screw-shaped samples. With appropriate plasma parameters, argon plasma remove all chemical traces from former treatments (adsorbed contaminants and other impurities, and native oxide layers), in effect producing cleaner and more well-controlled surfaces than with conventional preparation methods. Removal (sputtering) rates up to 30 nm/min are possible. However, when inappropriate plasma parameters are used, the result may be increased contamination and formation of unintentional or undesired surface layers (e.g., carbides and nitrides). Plasma-cleaned surfaces provide a clean and reproducible starting condition for further plasma treatments to form well-controlled surface

layers. Oxidation in pure O2 (thermally or in oxygen plasmas) results in uniform and stoichiometric TiO2 surface oxide layers of reproducible composition and thicknesses in the range 0.5-150 nm, as revealed by AES and XPS analyses. Titanium nitride layers were prepared by using N2 plasmas. While mild plasma treatments leave the surface microstructure unaffected, heavy plasma treatment can give rise to dramatic morphologic changes. Comparison of these results with corresponding analyses of commercial implants and electropolished and/or anodically oxidized samples shows that the plasma treatment offers superior control of the surface status. However, it is also shown that improper control of the plasma process can produce unwanted and irreproducible results.