Surface treatment on biomaterials: acid etching on titanium surfaces

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Introduction

Titanium is often used as a biomaterial and it is usually selected for dental implants. These titanium implants have a thin coating (2–5 mm) of TiO_2 which provides biocompatibility and chemical passivity to the base metal [1].

Different surface treatments are used to modify the topography and roughness of titanium to improve osseointegration. These processes aim at modifying the surface morphology which will be in contact with the tissues, and thus generating a better mechanical and biological anchoring. Among these treatments, the etching or acid attack is widely used, and it can be used as the single treatment or after a blasting treatment, known as SLA. Published results on surface studies with this dual treatment showed an increase of the rate and quantity of bone formation on the implant surface [2].

Several works indicate that the acid etching produces a rough topography with micropores which increases the contact area between the implant and the tissues holding it, and which provides good anchoring and osseointegration [3].

Experimental description

Grade 2 commercially pure titanium plates of 20 x 10 x 0.2mm were used as substrates, with two previous treatments: mechanical polishing up to 600-grain abrasive paper and blasting under industrial process conditions. Sulphuric acid and hydrochloric acid solutions with different concentrations (6M, 9M and 12M) were used. The topographic characterization was performed by scanning electron microscopy on a Philips SEM 505 equipment.

Surfaces roughness was measured with a Hommelwerke Tester T1000 profilometer by using the mean roughness value Ra as parameter.

Results

The acid etching caused different degrees of corrosion on the samples with prior polishing. The plates treated with 6M and 9M concentrations for both acids showed a rough morphology and micropores of less than 3µm in diameter, as shown in Figure 1.

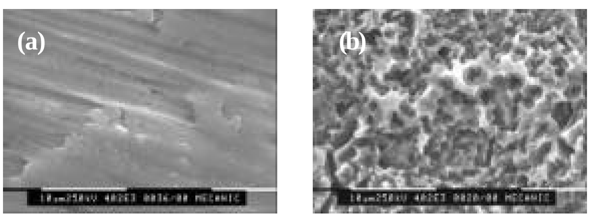

Figure 1. SEM images of polished samples prior to a) substrate b) treated with H_2SO_4 9M.

On the samples treated with blasting, the acid etching generated a similar topography, with irregularities and micropores, although the persistence of macroroughness caused by the previous treatment was observed. Some of the electronic micrographies are shown in Figure 2.

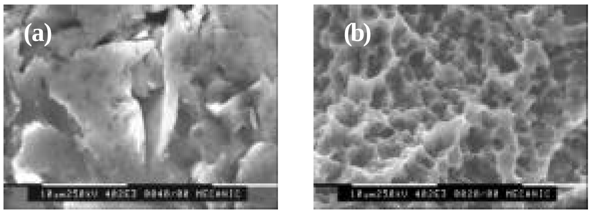

Figure 2. SEM images with samples with prior to a) substrate b) treated with HCl 9M.

In the substrates with previous mechanical polishing, the roughness after the treatment was higher in all cases than the one on the non-treated substrate. It was also observed that the parameter Ra increased with the concentration used for both acids.

The roughness of the substrate for the samples with treatment prior to blasting was higher than that for the samples with mechanical polishing. Figure 3 shows the Ra values, obtained for the different samples.

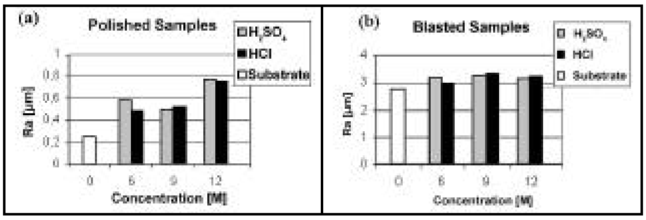

Figure 3. Mean values of Ra

Conclusions

The acid etching modified the topographies of the substrates in all cases. For the polished samples which were then attacked, different topographies were observed as the concentration of the acids increased. On the other hand, in the substrates with prior blasting treatment similar topographies were observed in all cases, with micropores with similar diameter. However, there continued to be irregularities on the surface due to material splitting caused by blasting.

The increase in roughness caused by the etching with different acids was the same for both substrates and, for the same concentration, there were no significant variations for the solutions used.

References

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