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Effect of bulk microstructure of commercially pure titanium on surface characteristics and fatigue properties after surface modification by sand blasting and acid-etching

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Abstract

Surface modification techniques are widely used to enhance the biological response to the implant materials. These techniques generally create a roughened surface, effectively increasing the surface area thus promoting cell adhesion. However, a negative side effect is a higher susceptibility of a roughened surface to failure due to the presence of multiple stress concentrators. The purpose of the study reported here was to examine the effects of surface modification by sand blasting and acid-etching (SLA) on the microstructure and fatigue performance of coarse-grained and ultrafine-grained (UFG) commercially pure titanium. Finer grain sizes, produced by equal channel angular pressing, resulted in lower values of surface roughness in SLA-processed material. This effect was associated with greater resistance of the UFG structure to plastic deformation. The fatigue properties of UFG Ti were found to be superior to those of coarse-grained Ti and conventional Ti-6Al-4V, both before and after SLA-treatment.

Keywords: titanium, surface modification, fatigue, nanocrystalline materials, equal channel angular pressing,

1. Introduction

Titanium and its alloys are widely used to produce medical implants for replacing damaged or missing load-bearing tissues. Titanium is ideally suited for such applications due to a combination of high corrosion resistance, light weight and good mechanical properties it possesses [1]. The surface of an implant plays a crucial role in cell response, particularly in bone replacement. The characteristics of a titanium implant surface govern cell attachment, spreading and proliferation in the process of osseointegration. Ultimately, this determines the quality of bonding between the newly grown bone tissue and the implant [2]. Therefore, a significant effort of researchers in recent years has been aimed at developing effective surface modification techniques to promote osseointegration. Most of the