Hybrid Surface Morphology of Ti-30Nb-xZr and Ti-30Ta-xZr Alloys by Electrochemical and Laser Methods

Han-Cheol Choe, Yong-Hoon Jeong
Department of Dental Materials, Research Center of Nano-Interface Activation for Biomaterials, & Research Center for Oral Disease Regulation of the Aged School of Dentistry, Chosun University, Gwangju, Korea
(E-mail : hcchoe@chosun.ac.kr)

Micro-roughness of implant surface is an application where mechanical interlocking of bone is essential to the improved performance of endosseous implants. Also, nanoscale surface modification of an implant surface could contribute to the mimicry of cellular environments to favor the process of rapid bone accrual. Using laser technique for roughening the implants surface, contamination can be avoided, because the laser enables implant surface treatment without direct contact, and an easier control of the micro-topography is achieved. Recently, femtosecond (10^{-15}sec) laser techniques have become an advanced tool for materials processing.

Comparative studies of laser materials processing have demonstrated that femtosecond lasers have advantages over nanosecond lasers in aspects of higher precision, reduced heat-affected zone, and smaller amount of debris around the ablated spot.

The electrochemical formation of highly ordered nanotube oxide layers has been reported for Ti anodization in fluoride-containing acid electrolytes at moderate voltages. In view of biomedical applications, these oxide nanotube layers can improve apatite formation ability and cell activity compared with conventional flat TiO_2layers.

In this study, the hybrid surface morphology of Ti-30Nb-xZr and Ti-30Ta-xZr alloys by electrochemical and laser methods have evaluated using various experiments. For this purpose, the characteristics of nanotube formation on the femtosecond laser surface were investigated by FE-SEM, EDX, XRD and XPS.

Ti-30Nb(Ta)-xZr alloys, with Zr contents ranging 3 and 15 wt.% were prepared using CP titanium, niobium and zirconium. The Ti-30Nb(Ta)-xZr alloys were manufactured using a vacuum arc-melting furnace (SVT, KOREA) in Ar atmosphere. The Ti-30Nb(Ta)-xZr alloys were homogenized in Ar atmosphere at 1000 °C (MSTF-1650, MS Eng, KOREA) for 24 h followed by quenching into 0 °C water. The ingots of Ti-30Nb(Ta)-xZr alloys were obtained in the form of rod with about length of 60 mm and diameter of 10 mm. For surface texturing, an amplified Ti: sapphire laser system was used for generating 184 femtosecond (FS, 10^{-15}sec) laser pulses with the pulse energy over 20μJ at a 1kHz repetition rate with acentral wavelength of 785nm. All nanotube formation experiments were carried out at constant voltage (10V) for 2h (potentiostat 362, EG&G Company, USA). The electrolyte was composed of $1MH_3PO_4$+0.8wt.%NaF. The phase and composition of nanotube formed and femtosecond laser textured surfaces were determined by using an X-ray diffractometer (XRD, X'pert PRO, Philips). (This study was supported by NRF: No.R13-2008-010-00000-0).