13th MULTINATIONAL CONGRESS ON MICROSCOPY

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BOOK OF ABSTRACTS

Ruđer Bošković Institute

Croatian Microscopy Society

13th Multinational Congress on Microscopy

September 24-29, 2017 in Rovinj, Croatia

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Editors

Andreja Gajović, Igor Weber, Goran Kovačević, Vida Čadež
Suzana Šegota, Petra Peharec Štefanić and Ana Vidoš

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The Multinational Congress on Microscopy 2017 has been designated an EMS Extension meeting by the European Microscopy Society.

POSTER PRESENTATIONS M7:

Fractographic analysis of biomedical Ti-based alloys with acicular microstructures

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Keywords: Biomedical Ti-based alloys, thermo-mechanical processing, fracture resistance, SEM observation, fractographic analysis

The mechanical biocompatibility is essential for biomedical Ti-based alloys used for orthopedic implants. Therefore, many studies are focused on decreasing the elastic modulus closely associated with the microstructural features. Recently, it is established that acicular microstructure, such as fully martensitic microstructure, results in a significant enhancement of the biomechanical compatibility. The obtained improvement depends on alloy chemical composition and geometrical parameters of acicular phase. Thus, a newly developed Ti-13Nb-13Zr (mass %) alloy has lower elastic modulus than standard Ti-6Al-4V (mass %) alloy in the same microstructural condition. On the other hand, a martensitic microstructure shows inferior fracture properties. The crack nucleation and propagation resistance of these implant materials is possible to optimize by the proper martensitic characteristics. A most critical parameter can be determined by the fracture surface morphology evaluation. In this study, the relationship between acicular microstructure, induced by different processing conditions, attaining the required biomechanical compatibility and fracture mode of Ti-13Nb-13Zr and Ti-6Al-4V ELI (extra-low impurity) alloys was established. Two microstructures with different untransformed β phase amount and martensite plates aspect ratio were developed by water quenching after

solution treatment above the *β* transus temperature. The scanning electron microscopy (SEM) observations of the broken tensile test specimen surfaces were correlated with their quantitatively determined geometric characteristics. The fractographic analysis reveals that presence of thin martensitic needles elongated to a higher extent than in Ti-13Nb-13Zr alloy microstructure, resulting in higher yield and ultimate tensile strength of the Ti-6Al-4V ELI alloy, experiences very limited plastic deformation before fracture. The fracture surface displays predominantly intragranular quasi-cleavage fracture mode. A so-called basket weave microstructure with coarser martensitic plates of smaller aspect ratio in Ti-13Nb-13Zr alloy hot rolled in the (*α*+*β*) phase field before quenching is beneficial to minimize the amount of cleavage facets. The larger amount of intragranular dimples mixed with those on the ridge walls, suggesting the change of dominant fracture mode, corresponds to one order of magnitude higher elongation at fracture. This indicates that martensitic microstructure produced through the applied thermo-mechanical processing of Ti-13Nb-13Zr alloy contributes to a superior tensile-fracture properties balance.

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