Title: Beta-Ti alloys for medical applications

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Abstract:

Interstitial strengthening by a high amount of oxygen can be used in metastable beta-Ti alloys, for achieving very high strength without compromising ductility. The content of oxygen however influences the phase stability and consequently increases the Young's modulus. Several alloys with various content of beta-stabilizing elements were prepared by common metallurgical route. On top of that, dozens of compositions were prepared by a high-throughput powder metallurgy method and thoroughly studied. Lattice softening due to proximity to a martensitic transformation was utilized to minimize the Young's modulus. Effect of omega phase was thoroughly studied; it was found that the embrittlement by the athermal omega phase is most probably connected with the high oxygen content and its room-temperature diffusion into omega particles. Fundamental difference between elastic behaviour of alloys containing a significant fraction of omega and those with only a limited amount of omega was demonstrated. Regarding the plastic deformation mechanisms, it was found that formation of stress-induced alpha″ martensite is related to differences in lattice parameters of the parent and martensitic phases, which depend on alloy compositions. However, utilizing transformation induced plasticity (TRIP) for ductility enhancement of alloys with high oxygen content was not successful. The thesis describes efficient methodological approach for development of advanced Ti alloys. Finally, alloys with promising properties for biomedical use were selected and characterized.

Keywords: Ti alloys, interstitial strengthening, phase transformations, lattice softening, mechanical properties