Title: Microstructure and mechanical properties of ultra-fine grained titanium alloys
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Abstract: Metastable β-Ti alloys Ti-15Mo and Ti-6.8Mo-4.5Fe-1.5Al (TIMETAL LCB) were subjected to severe plastic deformation by high pressure torsion. Microhardness of Ti-15Mo and TIMETAL LCB alloys increases with increasing inserted deformation, i.e. with increasing number of HPT rotations and also with increasing distance from the centre of the sample. The highest microhardness after HPT exceeds significantly the microhardness of two-phase $\alpha + \beta$ heat-treated material. Increasingly deformed microstructure was also demonstrated by scanning electron microscopy and by electron back-scattered diffraction (EBSD). Significant twinning was observed in both studied alloys. Mechanism of multiple twinning contributes notably to the fragmentation of grains and thus to the refinement of the microstructure. Defect structure in Ti-15Mo alloy was studied by positron annihilation spectroscopy. It was proved that dislocations are the only detectable defects in the material by positron annihilation spectroscopy and that dislocation density increases with the number of HPT revolution and with the distance from the centre on the specimen. The increase in the dislocation density is one of the causes of the increased microhardness of Ti-15Mo alloy. The effect of the HPT deformation on the phase transformations was examined by differential scanning calorimetry. Deformed microstructure significantly influences phase transformations in the material. The precise explanation of the effect of the ultra-fine grained microstructure on the phase transformations however requires detailed further investigations.

Keywords: ultra-fine grained materials, Ti alloys, microstructure, microhardness, electron back-scattered diffraction, defect structure, phase transformations