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ABSTRACT:

Diffusive and Displacive Phase Transitions in Ti Alloys by High Pressure Torsion

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Severe plastic deformation (SPD) not only leads to the strong grain refinement and material strengthening but also can drive the diffusive as well as diffusion-less (displacive) phase transformations. The influence of high pressure torsion (HPT) on the diffusive and displacive phase transformations in various binary Ti alloys with β-stabilizers (Fe, Co, Ni, Mo, Nb, Ta) alloys has been studied. Before HPT, the samples were annealed and contained (i) pure β-phase, (ii) α+β mixture with different portion of phases, (iii) α' or α'' martensites, (iv) the mixture of α-Ti and respective intermetallic phase. The microstructure of Ti alloys before and after HPT was studied by scanning and transmission electron microscopy (also high resolution one), X-rays diffraction (including the high-temperature in situ one), differential scanning calorimetry, atomic probe tomography, synchrotron irradaiation.

During HPT the α' martensite as well as high-pressure ω-phase are formed. The HPT-driven phase transitions can be martensitic (i.e. without or almost without mass transfer) or diffusional (i.e. with mass transfer). In case of martensitic β-to-ω or α-to-ω phase transitions, the certain orientation relations between β- and ω or α and ω were observed. The diffusion and diffusion-less mechanisms of these transformations are discussed. The thermal stability of the ω-phase obtained by HPT has been studied by the in-situ X-rays diffraction at high temperatures. The ω-phase in the HPT-treated Ti alloys with β-stabilizers can remain in the samples up to 500-600°C. It is much higher than in pure titanium (~150°C). Thus, the HPT-driven phase transitions open the new way for tailoring of grain size and phase composition of Ti-based alloys. In turn, it gives the new instrument in hands of engineers to improvement of the technologically important properties of Ti-based alloys. It is especially important for the medical application like the teeth of bone prosthesis.

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