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Alpha-To-Omega Phase Transition in Bulk Nanostructured Ti and (α+β) Ti Alloys

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Abstract : The high-pressure α- to ω-phase transition was discovered in elemental Ti and Zr fifty years ago using static high pressure and then observed to appear between 2 and 12 GPa at room temperature, depending on the experimental technique, the pressure environment, and the sample purity. The fact that ω-phase is retained in a metastable state in ambient condition after the removal of the pressure has been used to check the changes in magnetic and superconductive behavior, electron band structure and mechanical properties. However, the fundamental knowledge on a combination of both mechanical treatment and high applied pressure treatments for ω-phase formation in Ti alloys is currently lacking and has to be studied in relation to improved mechanical properties of bulk nanostructured states. In the present study, nanostructured (α+β) Ti alloys containing β-stabilizing elements such as Co, Fe, Cr, Nb were performed by severe plastic deformation, namely high pressure torsion (HPT) technique. HPT-induced α- to ω-phase transformation was revealed in dependence on applied pressure and shear strains by means of X-ray diffraction, transmission electron microscopy, and differential scanning calorimetry. The transformation kinetics was compared with the kinetics of pressure-induced transition. Orientation relationship between α-, β- and ω-phases was taken into consideration and analyzed according to theoretical calculation proposed earlier. The influence of initial state before HPT appeared to be considerable for subsequent α- to ω-phase transition. Thermal stability of the HPT-induced ω-phase was discussed as well in the frame of mechanical behavior of Ti and Ti-based alloys produced by shear deformation under high applied pressure.

Keywords : bulk nanostructured materials, high pressure phase transitions, severe plastic deformation, titanium alloys
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