Grain Growth Regularities During Annealing of High-Carbon Austenite Steel with a Microstructure Containing Deformation Twins

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Abstract. Phase composition, microstructure and microhardness of single crystals of high-manganese austenitic steels (HMAS) Fe-13Mn-1.3C, Fe-13Mn-2.7Al-1.3C, Fe-28Mn-2.7Al-1.3C (mass %) subjected to high-pressure torsion (HPT) and 1h-annealing in temperature interval (400 – 800)°C have been investigated. HMASs were solution-treated at temperature 1100°C for 1 hour and water quenched for obtaining an austenitic structure. HPT was conducted at room temperature (P = 5-6 GPa) for 1, 3 and 5 revolutions. After HPT-processing, annealing was performed at 400, 500, 600, 700 and 800°C for 1 h. The interval the thermal stability of microhardness for Fe-13Mn-1.3C, Fe-13Mn-2.7Al-1.3C steels, in which high density of twin boundaries are formed during HPT, is weakly dependent on the number of revolutions. During annealing above the thermal stability interval (500°C), the microhardness of HMASs decreases with increasing annealing temperature, a nucleation and growth of austenitic grains occur. For Fe-28Mn-2.7Al-1.3C steel after one HPT revolution, a misoriented austenitic structure with a low density of twin boundaries is formed. The microhardness in this case monotonically decreases with increasing annealing temperature. With increasing of strain (N = 3, 5), the microhardness in Fe-28Mn-2.7Al-1.3C steel increases due to the accumulation of deformation defects, mechanical twinning, formation of localization bands and deformation boundaries. The upper limit of thermal stability interval was determined to be 500ºC after HPT for 3 and 5 revolutions. Analysis of the microstructure and phase transformations occurring during annealing above the thermal stability interval of the structure of HMAS shown that high density of twin boundaries formed in steels during deformation by HPT and γ-α'-γ phase transformations implemented during annealing both prevent grain growth under annealing.
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