High Pressure Physics and Engineering 2013, vol. 23, № 3

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HYSTERESIS PHENOMENA IN γ/ε-PHASE TRANSITION

The obtained results of research of alloys on the basis of the Fe–Mn solid solution have revealed dependence of their structure and phase state on the parameters of SPD under pressure, and also on the initial phase and concentration composition that determine the level of mechanical and operational properties of materials of this class in the end. SPD increases efficiency of transformation at producing of close packed phases with HCP structure in high-manganese alloys under pressure. In this case, formed nanocrystallite structure increases hysteresis of baric α/ε/γ-transformations and, consequently, stabilizes high-pressure ε-phase in the investigated materials. For γ–ε-phase transitions, the hysteresis curves of loadings-unloading are built in the framework of nonequilibrium evolution thermodynamics. The dependences of the parameters of these curves (width of hysteresis versus excess free volume) on the coefficients of internal energy presentation are investigated. Hysteresis curves depending on the average grain size (or density of grain boundaries) are built. Generalization of model is pointed with taking into account the effect of manganese on stability of ε-phase in the alloy at atmospheric (more precisely, zero) pressure.

Keywords: phase transition, solid solution, alloy, nonequilibrium thermodynamics, severe plastic deformation

Fig. 1. Pressure dependence of concentration of high-pressure ε-phase C_ε in α-Fe (*a*) and in γ-$Fe_{55}Mn_{45}$ (*б*): CC – coarse-grain state ($d \approx 1000$ μm); NC – nanocrystal state ($d \approx 80$ nm)

Fig. 2. Effect of processing mode on stabilization of high-pressure ε-phase in Fe–Mn alloys vs manganese concentration C_{Mn}: *1* – the initial (hardened) state; *2* – HE (hydroextrusion) ($e \approx 0.5$, $P \approx 1$ GPa); *3* – impact-wave loading ($P \approx 16$ GPa) [2]; *4*, *5* – SPD by twisting at $e \approx 6$–7, $P \approx 10$ GPa and $e \approx 4$–5, $P \approx 20$ GPa, respectively

Fig. 3. The scheme of internal energy: *1*, *3* – the maximums of the internal energy; *2* – the minimum

Fig. 4. Hysteresis curve of γ/ε transition. The arrow marks the hysteresis width, the letters mark the succession of the stage of loading and unloading

Fig. 5. Hysteresis curve of γ/ε phase transition: *1* – $h = 0.1$, *2* – 1, *3* – 2