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EFFECT OF AGE HARDENING ON PHASE COMPOSITION AND MICROHARDNESS OF V-FREE AND V-ALLOYED HIGH-NITROGEN AUSTENITIC STEELS

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Effect of age hardening on phase composition and microhardness of high-nitrogen steels Fe-23Cr–17Mn–0.1C–0.6N (0V-HNS) and Fe-19Cr–22Mn–1.5V–0.3C–0.9N (1.5V-HNS) was investigated. Before age hardening (AH) treatments, specimens of V-free and V-alloyed steels were water-quenched (WQ) after 1200^0C (for 0.5 h) to produce supersaturated solid solution of interstitial atoms (nitrogen and carbon) in austenite (7% ferrite in 0V-HNS, no ferrite and <5% VN precipitates in 1.5V-HNS were formed). The age hardening treatment of WQ-specimens were realized at the temperatures of 700 and 800 °C for different heat duration from 10 minutes up to 10 hours.

According to XRD analysis, the change of phase composition of 0V-HNS steel during aging at temperatures 700 and 800 ^{0}C occurs in following way: γ_N-Fe+δ-ferrite (WQ) →γ_N-Fe + Cr_2(N,C) + ferrite + σ-phase (AH). The XRD line for δ-ferrite, corresponded to WQ state, is eliminated already after 10 minutes of AH, but the intensity of austenitic lines varies insignificantly due to the δ-ferrite transforms into σ-phase more likely than austenite. The lattice parameter of austenite decreases monotonously during aging at temperatures 700 and 800 ^{0}C. The X-rays lines tend to split and widen into higher diffraction angles with increase in aging temperature and duration. The aging of 1.5V-HNS at temperatures of 700 and 800 ^{0}C contributes to decomposition of □□-phase with formation of stable precipitates Cr,V(N,C) and ferrite: γ_N-Fe+ Cr,V(N,C) (WQ) →γ_N-Fe + Cr,V(N,C) + α′-phase (AH). In contrast to 0V-HNS, for 1.5V-HNS the value of lattice parameter of austenite decreases abruptly, the X-rays lines shift to higher angles with increase in aging duration at 800 ^{0}C and split after aging at 700 ^{0}C.

According to light microscopy, the microstructure of 0V-HNS has a mixed (duplex) characteristics and consists of clean particle-free grains (phase I-PI) and grains with numerous precipitates of second phase Cr_2N (phase II-PII). With the increase of aging duration, the volume fracture of PII grains became higher. After aging of 1.5V-HNS, precipitates were observed both along grain boundaries and in grains. The volume fraction of precipitates increases with increasing in aging temperature and duration.

After aging of 0V-HNS at 700 and 800 °C, the microhardness values for grains PI (untransformed austenite) are much smaller than those for PII-grains, but both dependences possess similar age-peak positions near 0.5-1 hours of age hardening. The following increase of aging duration up to 10 h leads to slight change of microhardness for both types of grains. Increased microhardness in PII-grains is associated with complex precipitate hardening and formation of hard intermetallic σ-phase. The slight decrease of microhardness after aging longer than 1-2 hours and appearance of plateau on dependence of microhardness on aging duration indicate the activation of coagulation processes. Aging of 1.5V-HNS is accompanied by monotonous increase of microhardness up to aging time of 10 h. During aging at 700 °C, the microhardness of the steel increases gradually due to precipitation hardening by V,Cr (N,C) particles, which suppress the coagulation processes. For aging at 800 °C above 30 min of aging duration, the microhardness does not change. This is, possibly, due to balance of hardening (precipitation hardening) and softening (recrystallization and depletion of austenite by interstitials during decomposition).

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