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ON SELECTION OF RATIONAL INTERCRITICAL ANNEALING TEMPERATURE OF A LOW-ALLOYED TRIP-ASSISTED STEEL

TRIP-assisted C-Si-Mn steels are usually subjected to austempering with a preliminary intercritical annealing. The latter that is targeted at the multi-phase structure having 40-60 vol.% of proeutectoid ferrite (F). The kinetics and the mechanism of phase-structural transformations can be impacted due to the additional alloying of TRIP-assisted steel by the strong carbide forming elements, necessitating an alternative approach for the selection of intercritical annealing parameters. This issue is analyzed in the present work, which investigates the effect of the temperature of intercritical annealing on the “Structure/Properties” correlations in 0.2 wt.% C-Si-Mn-Nb steel alloyed by 0.55 wt.% Cr, 0.20% Mo, and 0.11 wt.% V. The annealing temperature ranged from 770 °C to 950 °C, and austempering was performed at 350 °C for 20 min. It was observed that the addition of the (Cr, Mo, V) complex significantly improved the steel hardenability. However, the annealing of steel at 770 °C (to gain 50 vol.% of proeutectoid ferrite) resulted in the precipitation of coarse cementite lamellas during bainite transformation, lowering the amount of retained austenite (RA) and decreasing the strength and ductility of steel. At higher annealing temperatures, carbide-free bainite was formed, which presented a 2.5-3.5 times increase in the RA volume fraction and a 1.5 times increase in the RA carbon content. The optimal combination of the mechanical properties (yield strength of 900 MPa, ultimate strength of 1040 MPa, total elongation of 23%, V-notch impact toughness of 95 J/cm², PSE of 23.9 GPa·%) referred to annealing at a temperature close to the Ac₃ point, resulting in a structure with 5 vol.% F and 9 vol.% RA (the residue was carbide-free bainite). This structure presented an extended manifestation of the TRIP effect with an enhanced strain hardening rate due to strain-induced martensite transformation. The addition of Cr and Mo into C-Si-Mn TRIP-assisted steel promotes cementite formation decreasing the coefficient of carbon activity in austenite. This adversely affects the mechanical properties of the steel. Therefore, it is crucial to decrease the volume fraction of proeutectoid ferrite to prevent excessive carbon enrichment of austenite before the austempering holding.