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Strain-induced transformation of retained austenite in low-carbon low-silicon TRIP steel containing aluminum and vanadium

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Abstract

Effects of intercritical annealing temperature on the microstructure and mechanical properties in low-carbon low-silicon TRIP (transformation-induced plasticity) steel containing aluminum and vanadium were investigated. The highest volume fraction of retained austenite of samples annealed at 1053 K was approximately 18%, while the product of strength and elongation of samples annealed at 1033 K was up to 22,000 MPa%. In addition, the retained austenite transformation kinetics were measured by tensile test and fitted by the function $y = 1 - e^{-Ax}$. The correlation between the experimental and fitting results was good. A in the function might be a more effective factor to measure the mechanical properties of TRIP steel than the volume fraction of retained austenite.

Keywords: TRIP steel; Retained austenite; Transformation kinetics; Intercritical annealing temperature; Mechanical properties

chee and technology [1,2]. As a high-strength steel, it is applied to the manufacturing of automobile parts, being helpful to reduce the weight of automobile. In order to raise further the strength of TRIP steel, effects of micro-alloy elements, i.e. V, Nb and Ti [3–7] are studied. Much have been done for Nb and Ti, but little is concentrated at V, which may be caused by the fact that the vanadium carbide is easier to be dissolved than the carbides of other two elements [8,9]. In the previously paper, it is considered that even the vanadium carbide is dissolved during intercritical annealing, that vanadium in solution may improve the strength and increase the volume fraction of retained austenite [10].

In the present paper, effects of intercritical annealing temperature, at which ferrite and austenite coexist, on the microstructure and mechanical properties of low-carbon low-silicon TRIP steel containing aluminum and vanadium are studied. In addition, the composition of the TRIP steel studied is listed in Table 1.This steel was made in the technology center of Shanghai Baosteel. A sample was through pre-processed through vacuum melting, forging, homogenization annealing, hot-rolling, cold-rolling. The final thickness was 1.2 mm. The heat treatment of the specimen is shown in Fig. 1, and the annealing temperatures of the specimens at the intercritical zone were 1033, 1053 and 1073 K, respectively.

Samples are etched in Lepera reagent [11] to observe the microstructure. The volume fraction of retained austenite is measured by XRD with Cr radiation. The volume fraction of retained austenite is determined by the Direct Comparison Method to compare with the integrated intensity of the $(2\,2\,0)\gamma$ and $(2\,0\,0)\alpha$ peaks, and the carbon content of the retained austenite was obtained by the empirical relation [12]: $\alpha_\gamma = 0.35467 + 0.00467C_\gamma$. α_γ (nm) is the lattice parameter of retained austenite (γ) and C_γ (wt.%) is the carbon content of retained austenite. The line intersecting method was employed to obtain volume fraction of ferrite.

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