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CONTINUOUSLY ANNEALED COLD-ROLLED MICROALLOYED STEELS WITH DIFFERENT MICROSTRUCTURES

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THE VERSATILITY of a modern continuous annealing line(1,2) in generating different thermal profiles can be used to vary the nature of the second phase (carbides, pearlite, martensite) in a ferrite matrix that is either recovered or fully recrystallized. These different microstructures, in conjunction with alloying additions, can be used to generate different strength levels in cold-rolled steels, primarily for automotive applications.

Several investigations(3,4) have studied the effects of processing parameters and microalloying additions (Nb, V, Ti) on the tensile properties in recrystallized ferrite/pearlite steels. Ultra-high strength levels have been produced in recovered ferrite/martensite steels alloyed with Ti(5). Ti- and Nb-stabilized steels (interstitial-free steels) have received considerable attention for applications requiring excellent formability and strain-aging resistance(6). A recent investigation studied (a) the effect of Mn on the recrystallization behavior and tensile properties of recrystallized ferrite/ pearlite Nb and Nb-V steels and (b) the effects of alloying additions (Mn, Nb, V) and processing parameters on the tensile properties of recovered ferrite/ carbides and recrystallized ferrite/martensite steels. The findings of that investigation are discussed in this paper. In addition, the role of microalloying additions in continuously annealed cold-rolled sheet steels having different microstructures is reviewed.

EXPERIMENTAL DETAILS

To study the effects of alloying additions and processing parameters on tensile properties of steels exhibiting different microstructures, viz., recovered ferrite/carbides, recrystallized ferrite/pearlite and recrystallized ferrite/martensite, samples from a number of alloys were subjected to laboratory simulations of hot rolling and continuous annealing.

MATERIALS

To evaluate the effects of Nb and V, a .06 P/.50 Si steel (Alloy 2) was selected as the base alloy. Alloys 3 to 5 and 6 to 8 featured increasing levels of Nb and V, respectively. Mn additions ranging from about 0.4 to 1.6% were made to a .06 P/.04 Nb steel (Alloys 9 to 12) and a .06 P/.04 Nb/.085 V steel (Alloys 13 to 15) in order to investigate the effect of Mn. The detailed chemical analyses are given in Table I.

PROCESSING

Hot rolling of slabs to 2.5 mm hot band was conducted in the laboratory(7). Slabs were soaked at 1260°C for 1 h and reductions of about 50, 60, and 30% were taken at, respectively, 1095°C, 1010°C, and a finishing temperature of 895°C. Coiling temperature was varied between 565 and 730°C. The hot-rolled material was cold reduced about 70%. Continuous annealing was simulated by heating tensile specimens in a neutral salt bath and annealing for 1 min at various temperatures between 565 and 845°C. Following the anneal, different cooling paths and post-annealing treatments (Fig. 1) were employed to generate the different microstructures.