Behavior and Grain Refinement Efficiency of Deformed Acicular Ferrite and Lath Martensite Structures of C-Mn Steel

Subcritical recrystallization microstructure of partially homogenized and isothermally transformed Fe-2.5Mn-0.18C-0.03Ti (mass%) steel was studied by means of electron probe microanalysis (EPMA), optical microscopy and electron back scattered diffraction (EBSD). Isothermal transformation of austenite at 823 K for 1.8 ks produced Widmansttaten microstructure which turns to a duplex ferrite-austenite microstructure after cold rolling and recrystallization at 923 K for 3.6 ks.

Grain refinement efficacy of cold rolled and recrystallized low carbon steels is substantially enhanced by preliminary phase transformations [1]. For example, it has been shown that cold rolling and annealing of lath martensite gives rise to effective grain refinement [2]. Hossein Nedjad et al. [4] studied the grain refinement and tensile properties improvement of cold rolled and annealed acicular microstructures of Fe-C-Mn steels. A duplex microstructure consisting of Widmansttaten ferrite laths and martensite, obtained by isothermal transformation of austenite in a partially homogenized Fe-2.47Mn-0.18C-0.03Ti (mass%) steel, showed remarkable grain refinement and tensile properties improvement. Fig. 1 shows optical micrograph of the as-transformed microstructure. Supplementary optical microscopy, electron back scattered diffraction (EBSD) and electron probe microanalysis (EPMA) were used presently for better understanding of the as-transformed and recrystallized microstructures.

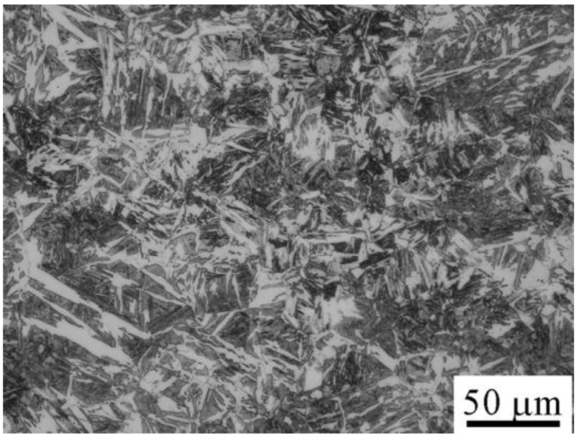

Fig. 1 Optical micrograph showing microstructure isothermally transformed for 1.8 ks at 823 K.

EPMA indicated heterogeneities in Mn distribution resulted from incomplete homogenization treatment. EBSD identified Kurdjamov-Sachs orientation relationship between ferrite laths and parent austenite phase.

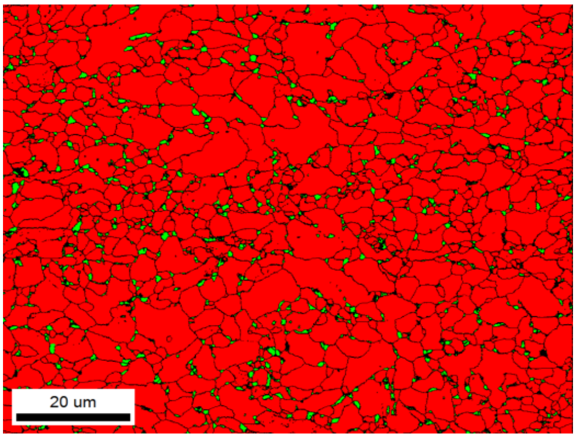

Fig. 2 EBSD phase mapping of austenite particles (green-coloured phase) and new ferrite grains (red-coloured matrix phase) in a specimen annealed for 3.6 ks at 923 K after cold rolling.

Discontinuous nucleation of occasional new ferrite grains and retention of fine austenite particles were found in a specimen annealed for 3.6 ks at 873 K after cold rolling. After annealing for 3.6 ks at 923 K, recrystallization takes place completely. Fig.2 shows an EBSD phase mapping of austenite particles (green-coloured phase) and new ferrite grains (red-coloured matrix phase) of the latter. Calculation of phase diagrams indicated that solute-enriched zones resulted from incomplete homogenization in association with solute partitioning during isothermal transformation possibly encounter subcritical annealing regime which leads to austenite reversion during annealing. The results adopt recrystallization behavior under practical conditions of incomplete homogenization in industrial rolling mills.

References

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