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Mechanical twinning by applying a secondary annealing heat treatment processing route in a high-alloyed boron-content TWIP steel

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This research work investigates the effect of boron content (180 and 470 ppm of B) on the mechanical twinning capability of the austenitic grain in a high Mn TWIP steel. For this purpose, three experimental TWIP steels were fabricated by melting commercial raw materials and cast into metallic molds, identified as TW-0 (steel of reference), TW-1 (steel with 180 ppm of B), and TW-3 (steel with 470 ppm of B). A specific processing route was employed which consisted consecutively in: i) destroying the solidification structure by a homogenization heat treatment at 1050 °C for 4 hours, ii) Hot rolling until obtaining 50% of thickness reduction and fast cooling to room temperature, iii) Cold rolling by applying 25% of thickness reduction, iii) Step secondary annealing heat treatment heated at 750 °C and soaked during 30 min and fast cooled to the room temperature and, finally, iv) Stress relieving heat treatment at 200 °C during 2 h followed by slow furnace cooling until room temperature. Microstructure characterization has shown that as the boron content in the TWIP steel increases, the austenitic grain size refines. In the same way, the nature of mechanical twinning is also well-defined as boron content increases. With respect to the TW-0, a hierarchical twinning has been observed. It is composed of fine mechanical twins and arranged in bundles of twins. However, the combined effect of the boron content and the proposed processing route has allowed the formation of primary and secondary mechanical twins in TW-1 and TW-2 steels, which are more clearly defined in TW-2. Consistent with this behavior, it can be concluded that the density of mechanical twins in the TWIP steel increases with the boron content when the proposed secondary annealing process route is applied.