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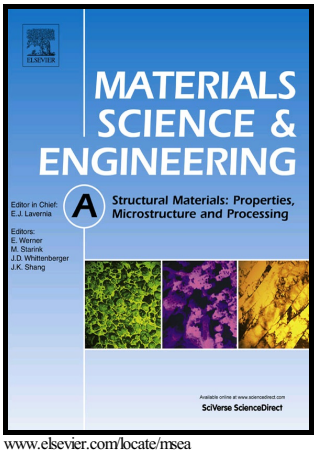

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Dependence of austenite stability and deformation behavior on tempering time in an ultrahigh strength medium Mn TRIP steel

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Abstract

In the present study, the microstructure, tensile property and deformation behavior were investigated in Fe-8Mn-8Al-0.8C steel after quenching and tempering treatment (Q&T). The steel exhibited a ferrite-austenite-martensite mixed microstructure, and a good combination of ultrahigh ultimate tensile strength (UTS) of ~1500 MPa and total elongation (TE) of ~30%. The tensile property was improved after tempering at 200 °C, which is mainly due to an improvement of austenite stability. Tempering process promoted the uniform distribution of carbon element in austenite, resulting in an elimination of the serrated behavior in the strain hardening rate curve. The element partitioning from the supersaturated martensite and δ-ferrite to austenite during tempering, as well as its contributing effects to austenite stability, was also discussed. Two methods were used to quantitatively monitor austenite stability as a function of tempering time with regard to transformation-induced plasticity (TRIP) effect. After an optimal tempering treatment at 200 °C for 60 min, the continuous strain-induced martensite transformation resulting from an optimized austenite stability led to an ultrahigh tensile strength and a product of strength and elongation (PSE) of 41 GPa·%. A fracture transition from brittle cleavage to ductile fracture was observed, which is due to variation of the local stress distribution between coarse δ-ferrite and adjacent austenite.

Keywords: Tensile property; Deformation behavior; Austenite stability; Element partitioning;

1. Introduction

Medium Mn TRIP steels with ultrahigh strength and considerable plasticity have been actively studied with increasing demand for strong steels in automotive industry [1-6]. Li [7] reported a hot-rolled Fe-6Mn-1.6Al-0.2C steel with a combination of UTS of 1040 MPa and TE of 41%. For another instance, UTS of 1095 MPa and TE of 42% were obtained in Fe-10Mn-1.5Al-0.14C steel [8].