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Editorial

Performance of Mechanical Properties of Ultrahigh-Strength Ferrous Steels Related to Strain-Induced Transformation

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1. Introduction

Ultrahigh-strength ferrous steels, related to the strain-induced martensite transformation (or transformation-induced plasticity: TRIP) of metastable retained austenite, such as TRIP-aided bainite/martensite steels, quenching and partitioning steels, nanostructured bainitic steels (or carbide free bainitic steels) and medium manganese steels, are currently receiving a great deal of attention from both academic and industry sectors, due to their excellent formability and mechanical properties. Many researchers are interested in the microstructure, retained austenite characteristics and tensile properties of the ferrous steels, which enhance the strength-ductility balance. To further apply the ferrous steels to a wide range of automotive components and parts, a detailed understanding of the performance of the mechanical properties, such as impact toughness, fatigue strength, delayed fracture strength and wear resistance after heat-treatment, thermo-mechanical process, plastic working (including hot-stamping, hot-forging), welding, surface treatment, etc., will be a great help to steel engineers in the future.

This Special Issue aims to address the performance of the mechanical properties of the ultrahigh-strength ferrous steels, as well as their strain-induced transformation behavior and the deformation mechanism.

2. Contributions

One review and nine research articles have been published in this Special Issue of Metals. The subjects of this Issue are roughly divided into four categories: (1) strain-induced transformation behavior [1–3], (2) deformation mechanism [4,5], (3) formability [6,7] and (4) mechanical properties [8–10] of the ultrahigh-strength ferrous steels. The abovementioned (1) and (2) give important information for improving (3) and (4).

First, fundamental studies on the strain-induced transformation behavior of metastable retained austenite were conducted. Kaar et al. [1] studied the influence of quenching and partitioning processes on the transformation kinetics in a lean medium manganese TRIP steel. The paper by Grajcar et al. [2] dealt with the effect of the retained austenite size on the strain-induced transformation behavior during tensile deformation of hot-rolled multiphase steel. Hossain et al. [3] investigated the mechanical stability of retained austenite in high carbon steel, under compressive stress at different strain rates.

Second, the deformation mechanism of the ferrous steels was investigated using various microscopes. Tang et al. [4] reported the effect of the deformation temperature on the deformation mechanism of cold-rolled, low carbon, high manganese austenite/ferrite steel. Grzegorczyl et al. [5] reported the Portevin-Le Chatelier effect at 20 to 140 °C, in a hot-rolled, medium Mn bainite/martensite steel.

Third, the formability of the ferrous steels was related to the microstructure and the retained austenite characteristics. Kaar et al. [6] studied the structure-ductility relationship in cold-rolled

medium manganese bainite/martensite steels subjected to quenching and partitioning processes. Yang et al. [7] investigated the springback behavior during the bending process for a quenching and partitioning steel.

Finally, mechanical properties, such as the impact toughness, fatigue strength and delayed fracture strength, of the ultrahigh-strength steels were investigated, and the fracture mechanisms were proposed. Sugimoto et al. [8] reported that chromium-molybdenum-bearing, hot-forged, medium carbon, TRIP-aided bainitic ferrite steels achieve excellent impact toughness. To apply the TRIP-aided martensitic steels to precision gears, Sugimoto et al. [9] reviewed the effects of the heat treatment and case-hardening processes on the fatigue strength, as well as hardness and residual stress in the surface hardening layer. Hojo et al. [10] studied the effects of alloying elements on the delayed fracture strength of TRIP-aided martensitic steels.

3. Conclusions and Outlook

A variety of topics concerning ultrahigh-strength ferrous steels were collected in this Special Issue. At present, most of the ferrous steels are applied to cold sheet parts. However, they may be used as the materials of hot-forged parts in the future, because of the excellent performance of the mechanical properties. I hope that many researchers will have an interest in the applications of the ferrous steels in the hot-forging of parts.

As a Guest Editor, I would like to thank all the authors for their academic contributions to this Special Issue. I would also like to give special thanks to all staff at the Metals Editorial Office.

Conflicts of Interest: The author declares no conflicts of interest.

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