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Editorial

Special Issue on Recent Trends in Advanced High-Strength Steels

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1. Introduction

Advanced high-strength steels play an essential role in many industries and engineering applications because of their excellent combination of mechanical properties important for design, e.g., strength, fatigue, fracture, wear, and manufacturability. In many challenging applications, structural components can be subjected to severe service conditions, and therefore, high-strength steels are often the only choice in these applications. Therefore, understanding the relationships between the mechanical properties and the chemical composition, microstructural features, and manufacturing methods are pivotal to develop safe and durable structures.

The goal of this Special Issue is to foster the dissemination of the latest research outcomes in the field of advanced high-strength steels from various perspectives. In this volume, a total of thirteen papers addressing several important research problems and developments have been collected, namely the relationship between microstructure and mechanical properties, the effect of heat treatment variables on the mechanical behaviour, fatigue and fracture resistance under different loading conditions, and weldability. These articles represent a significant contribution to the research field.

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2. Contributions

The interconnection between the microstructure and bulk mechanical properties has been the focus of many investigations. The development of deep knowledge regarding the above-mentioned relationship opens many cost-effective opportunities for new applications as well as for cost-optimisation of the current engineering designs. In this volume, Ali et al. [1] studied the effects of chromium content on the microstructure and mechanical properties of low-carbon bainitic steel containing niobium processed by thermomechanical hot rolling. Chen et al. [2] evaluated the mechanical properties and the phase transformation temperature in a transformation-induced plasticity (TRIP) steel subjected to room and high temperatures.

Currently, various heat treatment procedures are the most common methods to improve the bulk mechanical properties of advanced high-strength steels; this may justify the intensive research in this field. Haiko et al. [3] investigate the influence of tempering temperature on both the microstructure and monotonic stress-strain response in a new ultra-high-strength steel with low carbon content. Honma et al. [4] analysed the effect of intercritical quenching temperature on the strength and toughness in a low-alloy steel developed for offshore applications. Gu et al. [5] developed a numerical approach to evaluate the effect of different inclusions on the residual stress profiles during the cooling process for martensitic steels. Grajcar et al. [6] addressed the influences of isothermal holding time and temperature on the stability of retained austenite in medium manganese bainitic steels with and without niobium addition.

Mechanical behaviour under cyclic loading is crucial for designing structural components against fatigue. This maintains the need to understand the fatigue failure and fracture mechanisms of advanced high-strength steels under various loading histories. Wang et al. [7] studied the collapse of an adjustable ballast tank used in deep-sea submersibles made of an ultra-high-strength maraging steel. The fatigue crack growth in 18Ni300 maraging steel was also studied by Antunes et al. [8], using various fracture mechanic parameters, namely the classic stress intensity factor range and the newly proposed plastic crack-tip opening displacement. Dealing with the same maraging steel, Mooney et al. [9] developed a constitutive elastic-plastic model to simulate the cyclic response of the material under strain-controlled loading conditions. Ottersböck et al. [10] presented a new procedure based on the digital image correlation technique to track both the fatigue crack initiation and the fatigue crack propagation regimes in butt joints made of ultra-high-strength steel.

Establishing the link between the resultant mechanical properties of the fabricated materials and parameters of advanced manufacturing methods is always challenging and very important for potential applications. Santos et al. [11] evaluated fracture toughness of maraging steel implants fabricated by laser-beam powder-bed fusion methods. Ndubuaku et al. [12] proposed a robust and straightforward model to characterise the deformation response of high-strength steel used in pipelines. In a comprehensive state-of-the-art review, Królicka et al. [13] addressed the welding methods, process parameters, and weldability aspects of different high-strength steels; in particular, high-carbon nanobainitic steels.

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