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Editorial

High-Strength Low-Alloy Steels

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1. Introduction

Modern industry, driven by the recent environmental policies, faces an urgent need for the production of lighter and more environmentally friendly components. High-strength low-alloy steels are key materials in this challenging scenario because they provide a balanced combination of properties, such as strength, toughness, formability, weldability, and corrosion resistance. These features make them ideal for a myriad of engineering applications which experience complex loading conditions and aggressive media, such as aeronautical and automotive components, railway parts, offshore structures, oil and gas pipelines, power transmission towers, construction machinery, among others. The goal of this Special Issue is to foster the dissemination of the latest research devoted to high-strength low-alloy (HSLA) steels from different perspectives.

2. Contributions

The understanding of the microstructure features and their dependence on the mechanical behaviour is of essential importance for the development of safe and durable components as well as to extend the scope of application of the high-strength low-alloy steels. This may justify the intense research conducted on the triangular relationship between the microstructure, the processing techniques, and the final mechanical properties. Solis-Bravo et al. [1] addressed the relationship between the precipitate morphology and dissolution on grain coarsening behaviour in microalloyed linepipe steels with different contents of titanium and niobium. The effect of the hot deformation and the cooling path on the phase transformation kinetics of precipitation-strengthened automotive steels with different contents of titanium and niobium was also examined by Grajcar et al. [2]. Xie et al. [3] studied the effect of nanometre-sized interphase-precipitated carbides on the improvement of monotonic tensile strength in fire resistant hot-rolled steel at room and high temperature. The effect of dissolution and precipitation of different carbides at high temperature on the microstructure of a low-alloy chromium-containing heat-resistant steel was also analysed by Li et al. [4].

Regarding the processing techniques and the evaluation of mechanical properties, different research lines were followed. Guo et al. [5] evaluated the casting process conditions on the mechanical properties of hot-rolled steel and studied the billet quality by developing and optimisation method. Khosravani et al. [6] tackled the microstructural changes that occur during the processing of dual-phase steels by using multiresolution spherical indentation stress–strain tests. Dzioba et al. [7] focused on the effect of temperature on fracture toughness and tensile strength properties of low-carbon high-strength steel. Iob et al. [8] examined the anisotropic mechanical behaviour of high-strength low-alloyed steel based on the micro-void and ductile fracture. The mechanical properties of high-strength low-carbon steels, with different contents of molybdenum and niobium, processed thermomechanically and subjected to direct quench were investigated by Hannula et al. [9]. A numerical study to deal with the cutting problem of ultra-thin steel sheets made of cold rolled steel was developed by Kaczmarczyk et al. [10].

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Another active area of research has been welding engineering. It has not been focused on the optimisation of welding techniques but also on the evaluation of microstructure features and mechanical properties. Mičian et al. [11] studied the influence of the cooling rates on mechanical properties of the heat-affected zone, obtained by metal active gas welding, in S960ML high-strength structural steels. The effect of the welding heat input on the heat-affected zone of S960QL high-strength structural steels was also investigated numerically by Gáspár [12]. Moravec et al. [13] examined the effect of grain growth kinetics on the changes of the mechanical properties of the heat-affected zone in a S700MC fine-grained high-strength steel. The fracture toughness response under static and dynamic loading in the same material was examined by Schmidová et al. [14].

The presence of abrupt geometrical changes in conjunction with complex cyclic loads make most mechanical components prone to fatigue failure. This means that engineering design must be able to account for the loading history, the geometrical effects, the environmental effects, and the processing variables, among others. Jiménez-Peña et al. [15] compared the fatigue response of high-strength low-alloy plates with holes manufactured by five processes, namely punching, drilling, waterjet-cut, plasma, and laser-cut. Guo et al. [16] evaluated the variability in the mechanical properties of pipeline steel associated with the centreline segregation in continuously cast slab to meet the requirements of strain-based design. Ślęzak [17] studied the fatigue crack initiation and fatigue crack growth in welded joints made of S960QL high-strength low-alloy steel subjected to strain-controlled conditions. Harun et al. [18] analysed the effect of the localized wall thinning on low-cycle fatigue resistance of elbows, with artificially introduced defects, made of C70600 steel from full-scale tests.

The fatigue design under multiaxial loading is another challenging topic. The development of multiaxial fatigue assessment models as well as the identification of adequate fatigue damage quantifiers remain important objectives for the scientific community. However, it is a very complex task because, in general, multiaxial fatigue response is associated with a huge number of variables. Pawliczek and Rozumek [19] presented an algorithm based on the Palmgren–Miner linear damage rule for calculating the fatigue life in S355J0 steel specimens subjected to multiaxial non-zero mean stress histories. Cruces et al. [20] compared the predictive capabilities of different critical plane-based models for hollow specimens made of S355-J2G3 steel subjected to in-phase and out-of-phase axial–torsional loading in the low-cycle and the high-cycle fatigue regimes.

Within the high-strength low-alloy steels, the third generation plays an important role. The macroscopic mechanical response of this new generation can be further improved by a better understanding of the failure mechanisms on the microstructural level under different service conditions. Shakerifard et al. [21] conducted a comprehensive microstructural characterization of a multiphase low-silicon bainitic steel using a scanning electron microscope (SEM) equipped with an electron backscatter diffraction detector. Concerning metallic structures operating in soils and natural waters, corrosion under the effect of a stray current is among the most hazardous types of damage. Rybkina et al. [22] addressed the effect of sign-alternating cycling polarisation on the localised corrosion of pipelines made of X70 steel subjected to various pH-neutral solutions.

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