Post-processing improvements for mechanical, microstructure, and surface properties of steel

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Editorial

Post-Processing Improvements for Mechanical, Microstructure, and Surface Properties of Steel

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1. Introduction and Scope

Post-processing treatments of metallic materials play a key role in the achievement of high mechanical and surface properties of the final components and in the optimization of their behavior in service conditions. Thermal or finishing processes determine the development of specific microstructures, influencing material properties but also cost and time for industrial production. New technologies for steel forming often require the set up and the optimization of post-processing treatments, understanding their influence on microstructural, mechanical and surface properties. Optimized post-processed components with improved mechanical and functional behaviors can be exploited for innovative applications, for molds, aerospace, automotive, transportation, energy, oil and gas, tools, etc.

2. Contribution to the Special Issue

Researchers around the globe investigating microstructures, composition and mechanical or functional properties of steel parts realized through innovative forming and manufacturing technologies and their changes with post-processing treatments have been invited to submit research papers so that readers can recognize the common points between them. Among the submitted manuscripts, six papers have been published in the issue.

2.1. Effect on Microstructure, Composition and Mechanical Properties

In recent years, many research efforts have been focused on the optimization and improvement of innovative forming and manufacturing technologies for the production of steel parts. Deep drawing, for instance, is an innovative sheet metal forming method employed for producing precise and complex-shape, symmetrical and a symmetrical three-dimensional parts [1]. In order to avoid fracture, wrinkling and earing, the deep drawing can be carried out at elevated temperatures implying changes in microstructures and mechanical behavior [2]. Complex-shape symmetrical three-dimensional parts can be realized also by Laser Metal Deposition processes, one of the Additive Manufacturing technologies [3]. Building parameters, such as laser power, track overlap and deposition strategy, strongly affect the cooling rate conditions and consequently, microstructural and the mechanical characteristics of the deposited steel components [4]. The presence of high-energy states, as in additive manufactured parts or in cold-worked components, can play a relevant role in the definition of thermal treatments. For instance, specimens cold-worked through surface local plastic deformation processes can undergo different microstructural and phase evolutions during annealing on the basis of the distribution of energy states [5].

2.2. *Effect on Corrosion Behavior*

The corrosion of steel components is a critical aspect for some application fields, such as oil and gas or civil engineering. The consequences of a corroded surface on the structural behavior of steel structures on the subsequent strength decrease can be more accurately predicted thanks to the application of IoT principle and in particular, through a machine learning approach. A convolutional neutral network can support the image analysis of corroded surfaces for its precise definition, in order to improve the accuracy of FEM simulation of structural performances of steel structures [6]. On the other hand, in the case of reinforced concrete structures, it has been demonstrated that the rebar corrosion can depend on its surface state and the passivation and anticorrosion behavior can be improved through rebar surface treatments [7]. Finally, in the case of steel, hot work sliding parts specific surface modifications must be developed for guaranteeing corrosion and wear resistance through boriding or yttria-stabilized zirconia thermal spray coating [8].

3. Conclusions

The Special Issue, "Post-Processing Improvements for Mechanical, Microstructure, and Surface Properties of Steel" deals with research articles focused on the mechanical, microstructural and surface properties of steel parts processed through innovative technologies. The guest editor believes that the selected papers may be useful to people who are actively involved (directly or indirectly) in this field. This Special Issue is already a success, but if the articles in this issue can inspire and invite more research studies, debates, and discussion in the field, that would make it even more special.

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