metals

Editorial

Heat Treatment of Iron- and Aluminum-Based Alloys

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Iron- and aluminum-based alloys are the most commonly used metallic materials for engineering applications. These metals can have optimal chemical and physical (i.e., mechanical and corrosion resistance) properties thanks to the correct balance of alloying elements. Heat treatments are used to modify these properties, affecting the microstructure of the metal. The microstructural changes due to thermal treatments can be used for secondary purposes, for example, to obtain a good response to other operations performed on mechanical components (i.e., non-destructive tests). For many metals, heat treatments are unavoidable when attempting to obtain the desired service behaviors; however, in recent years, the environmental impact aspect has become even more important. Indeed, heat treatments are energy-consuming, and the optimization of the processes can lead to more sustainable production.

Research on the heat treatment of steel is still very important. In [1], the effects of the microstructural features on the torsional ductility of cold-drawn and annealed hypereutectoid steel wires were investigated. The effect of annealing on the microstructure, particularly the shape of the lamellar cementite, influences the number of turns and the behavior of these peculiar components used in highly demanding applications. If the lamellae align during straining along the wire axis, the number of turns will increase. On the other hand, in the annealed conditioning, the number of turns of the steel wires decreases with the treatment time, owing to the spheroidization and growth of cementite particles, and the recovery of ferrite.

Even more attention has been paid to the heat treatment of stainless steels. In this case, the treatment is performed not only to obtain better mechanical properties but also to achieve a high level of corrosion resistance. For this reason, it is very important to know the precipitation range of detrimental secondary phases to avoid deleterious combinations of time and temperature. This knowledge is also important for implementing heat treatments that enable researchers to avoid these dangerous situations.

Arh et al. [2] investigated the solidification behavior of laboratory-cast austenitic SS2343 stainless steel in terms of the volume fraction of δ-ferrite in the as-cast state, and its transformation after subsequent annealing. Their study suggests different types of annealing to reduce the δ-ferrite content by approximately 50%. Moreover, heat treatment influences the morphology of the interdendritic ferrite and can reduce the amounts of Cr and Mo in this phase.

In [3], the results of secondary phase precipitation in one grade of duplex stainless steel (DSS) in the temperature range of 850–1050 °C for 3–30 min are presented. This study identified the key factors in designing optimal welding processes that avoid any secondary phase precipitation in the weld bead, as well as in the heat-affected zone. In [2,3], thermodynamic calculations were used, and the numerical results were in good agreement with the experimental results. This underlines the important role of simulations in the study of heat treatments.

In relation to duplex stainless steels, the authors of [4] presented a problem related to the peculiar microstructure of these steels. Different soaking times at 1050 °C of DSS resulted in different amounts of ferrite and austenite. This implies that a different response

Citation: Barella, S. Heat Treatment of Iron- and Aluminum-Based Alloys. *Metals* **2023**, *13*, 1141. https://doi.org/10.3390/met13061141

Received: 22 May 2023
Revised: 7 June 2023
Accepted: 15 June 2023
Published: 19 June 2023

to the ultrasound is used to measure the soundness of a component. In particular, the peak of sound attenuation corresponds to the major amount of austenite and the disappearance of secondary austenite within the ferritic matrix. The results show that soaking should last for as little time as possible to improve all the properties.

As stated previously, emission reduction and an increase in the efficiency of the furnace are fundamental. In [5], the benefits of using oxyfuel practice for CH_4-fueled combustion are shown. However, this practice can alter the atmosphere in which the oxidation of steel occurs and, consequently, the thickness and morphology of the oxide layer. In this case, the use of lean oxyfuel was considered the best alternative.

In light of the emission reduction, an increase in the mechanical properties using the optimal heat treatment is crucial. Higher mechanical properties with the same chemical alloy composition indicate a light weight and emission reduction for the transport components. In [6], the effects of natural aging and bake hardening on an AA6014 aluminum alloy were investigated. The yield strength stabilized after 90 d of natural aging owing to the end of the Portevin–Le Chatelier phenomenon. This can assist car manufacturers in the production process.

In conclusion, a lot of knowledge has been acquired from ancient blacksmiths, but this field is already a breeding ground for research.

Acknowledgments: I would like to acknowledge Andrea Gruttadauria for the help in revising this editorial and for his friendly support.

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

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