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Editorial

Microstructure and Mechanical Properties of Structural Metals and Alloys

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1. Introduction and Scope

Mechanical properties of polycrystalline structural metals and alloys are significantly affected by their microstructures including phase content, grain/subgrain sizes, grain boundary distribution, dispersed particles, dislocation density, etc. The development of metallic materials with desired structural state results in beneficial combinations of mechanical properties. Specific alloying designs along with a wide variety of thermal, deformation, and many other treatments are used to produce metallic semi-products with favorable microstructures in order to achieve the required properties. Therefore, the studies on structure–property relationships are of a great practical importance. The aim of this special issue is to present the latest achievements in theoretical and experimental investigations of mechanisms of microstructural changes/evolutions in various metallic materials subjected to different processing methods and their effect on mechanical properties.

2. Contributions

The present special issue on the microstructure and mechanical properties of structural metals and alloys collects papers dealing with various aspects of microstructure–property relationships of advanced structural steels and alloys including commercial and novel materials. A total of 22 papers cover a ranger of structural metals and alloys. The major portion of these papers is focused on the mechanisms of microstructure evolution and the mechanical properties of metallic materials subjected to various thermo-mechanical, deformation, or heat treatments [1–12]. Another large portion of the studies is aimed on the elaboration of alloying design of advanced steels and alloys [13–16]. The changes in phase content, transformation, and particle precipitation and their effect on the properties are also broadly presented in this collection [17–21]. In two papers [19,22], particular emphasis is placed on the microstructure/property changes caused by irradiation.

Those readers interested in structural steels may learn much from comprehensive investigations of microstructural changes and their effect on mechanical properties caused by plastic working and heat treatment of diverse steel types [2,7,8,10,12,15,16,19–22]. Two of these papers [7,12] present experimental/simulation results of mechanical behavior of high-Mn TWIP steels, which have recently aroused a great interest among material scientists and engineers because of outstanding strength–ductility combination inherent in such steels. Some crucial features of structure–property relations are detailed for advanced heat resistant [10,15,19,22] and stainless [8,21] steels. Materials scientists working with aluminum alloys may find many interesting results for dispersion strengthening, including processing, structural/precipitation analysis, and mechanical testing [13,17,18]. As a guest editor, I have the pleasure to note that present collection is not limited to such frequently used materials like steel and aluminum alloys. Interested readers will find attractive reports on magnesium [1], nickel [3], titanium [4,5], copper [6,11], and tin [14] alloys. Those who are interested in innovative materials, and their processing and applications, are suggested to take a good look at Ti/TiB metal-matrix composite [5] and high-entropy alloys [9]. The great diversity of materials, which are presented in this special issue, involves various techniques of their production. Worthy of mention are severe plastic deformation [5,9] and welding [8,10] as topics of quickened interest. As a guest editor, I sincerely believe that every reader among materials scientists will find interesting and useful information in the present special issue.

3. Conclusions and Outlook

The papers collected in this special issue clearly reflect the modern research trends in materials science. These fields of specific attention are high-Mn TWIP steels, high-Cr heat resistant steels, aluminum alloys, ultrafine grained materials including those developed by severe plastic deformation, and high-entropy alloys. In spite of great effort in the development of advanced structural metals and alloys, these topics deserve further comprehensive investigations. The engineering and technology progress is closely related with the development of new structural materials with improved mechanical properties. This requires deep knowledge of mechanisms and regularities of microstructural changes during processing and exploitation, as well as clear understanding of microstructure–property relationships. No doubt, structural materials will continuously attract a great interest among materials scientists and engineers.

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