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Editorial

Inclusion Metallurgy

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1. Introduction and Scope

Non-metallic inclusions have a great influence on the cleanliness and mechanical properties of steel. By controlling the size and composition of inclusions, the excellent properties of "clean steel" can be maintained. At the same time, in terms of our understanding of inclusions' behavior using thermodynamics principles, the design and control of the composition, shape, size, and distribution of non-metallic inclusions in different steels can significantly enhance their properties.

The primary focus of this Special Issue is on recent advancements in inclusion engineering which have the aim of controlling steel cleanliness and microstructure through modeling and experimental work. Research into the particularly interesting theme of the formation mechanism and evolution control methods of inclusions in the smelting process in laboratories and steel plants was welcomed. The study of the agglomeration and floatation of inclusions and the kinetics of slag adsorption in the process of refining and solidification were also potential themes.

2. Contributions

In this Special Issue, 10 high-quality papers covering a wide range of inclusion metallurgy research, including rare earth treatment, electroslag remelting, the formation and evaluation of inclusions during steel smelting, and the effect of inclusions on mechanical properties and solidification structures have been published.

Five papers focused on the effect of rare earth on steel, which clarified the effect of sulfur on inclusions and the mechanical properties of Ce-Mg-treated, resulfurized SCr420H steel [1]; the evolution of inclusions in austenitic heat-resistant steel with different levels of Ce content during protective argon gas atmosphere electroslag remelting (ESR) [2]; the effect of Ce on the morphology of manganese sulfide [3]; the effects of rare earth La–Ce alloying treatment on the characteristics of steel [4]; and the effect of rare earth Ce content on the morphology, composition, type, and size distribution of inclusions in W350 non-oriented silicon steel [5].

Four papers focused on the formation and evolution of inclusions during steel smelting, which covered the formation and removal mechanisms of inclusions in 42CrMo4 steel during the steelmaking process [6]; the evolution of inclusions and the control strategies used to improve the cleanliness of molten steel in Ti-bearing IF steel [7]; the source and formation of magnetic particle inspection defects identified on the near-surface of the Cr5 back-up roll-forged ingot [8]; and the origin, evolution, and formation mechanism of MgO-based inclusions in Si-Mn-killed steel [9].

One paper focused on the solidification behavior and structure of 2311 die steel with a cross-section dimension of 415 × 2270 mm at different casting speeds, specific water flow, and superheat [10].

3. Conclusions and Outlook

Topics such as the effect of rare earth on steel, the formation and evolution of inclusions during steel smelting, and solidification behavior and structure are covered in this Special

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Citation: Zhang, Y.; Cheng, G.; Zhan, Z. Inclusion Metallurgy. *Metals* **2023**, *13*, 827. https://doi.org/10.3390/met13050827

Received: 28 March 2023
Accepted: 31 March 2023
Published: 23 April 2023

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Issue, which presents the latest developments in inclusion metallurgy research and their applications. As Guest Editors of this Special Issue, we hope that the reported studies will be useful to researchers in advancing their respective research areas.

Funding: This work was supported by the National Natural Science Foundation of China, grant numbers U196021 and 51874034, the National Natural Science Foundation of China N. 52074075 and the National Key Research and Development Program of China N. 2016YFB0300105, the National Natural Science Foundation of China (Grant Nos. 52074027 and 51874026), the National Natural Science Foundation of China, grant number 51874028, the National Natural Science Foundation of China (Grant No. 51774031), the National Natural Science Foundation of China, grant number 51774030, the National Natural Science Foundation of China (Nos.52274312 and 51804003), the Fund of Education Department of Anhui Province (Nos. 2022AH050291, 2022AH050293), the Open Project Program of Anhui Province Key Laboratory of Metallurgical Engineering & Resources Recycling (Anhui University of Technology) (Nos. SKF21-04 and SKF21-05), the University Natural Science Research Project of Education Department of Anhui Province (No. KJ2021A0396), and the Jiangxi Province Major Scientific and Technological Research and Development Special Funding Project (20213AAE01009).

Acknowledgments: As Guest Editors, we highly appreciate the valuable research from the contributing authors, the professionalism of the reviewers and editors, and the efforts of the staff working on this Special Issue. Special gratitude goes to the *Metals* Editorial Office for its great support.

Conflicts of Interest: The authors declare no conflict of interest.

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