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Field-Intensified Metallurgy

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Interest is high in applying external fields, e.g., microwave and electric fields, to various metallurgical routes to gain maximum economic and environmental benefits.[1,2] In this special topic on Field-Intensified Metallurgy, we will provide our readers interesting and exciting updates on improving various metallurgical processes by applying different fields. Also covered will be advances in addressing the challenges or problems that may restrain the development of field-intensified metallurgy.

Microwave fields have been extensively used for treatment of metallurgical solid waste because of their selective and volumetric thermal effects.[3] In the first article of this series, "Synthesis of Rutile TiO_2 from Panzhihua Sulfate Titanium Slag by Microwave Heating," Hufei Chen et al. describe a novel microwave technology for the synthesis of rutile TiO_2 from a sulfate titanium slag. The microwave field has proven effective in accelerating the transformation of the anosovite phase of sulfate titanium slag to the rutile TiO_2 phase at 1100°C for a duration of 120 min. The findings were based on exploration of the changes in physicochemical properties of sulfate titanium slag under microwave irradiation, including crystal structure, surface microstructure, and surface chemical functional groups. This study verified the great potential of microwave heating in triggering the process of production of rutile TiO_2 from titanium slag and other relevant secondary resources.

In the next article of this series, "Arcmon for Process Control in Silicomanganese Production: A Case Study," Joalet Dalene Steenkamp et al. propose the use of Arcmon, a device for quantifying the amount of undesirable arcing that occurs as a result of applying electric fields in submerged-arc furnaces (SAFs) for process control in silicomanganese production. It was based on the authors' observation of the differences in arcing behavior between the three different electrodes in a 48-MVA SAF used for the production of SiMn, resulting from the presence of a hard build-up which consisted primarily of portlandite and silicon carbide below the electrodes. The Arcmon was found to be effective in identifying the presence of such a build-up, offering an opportunity for its removal to ensure sufficient coke-bed volume available for the alloy production through reduction.

There is no doubt that field-intensified metallurgy also relies on the thermodynamic analysis of the associated reactions occurring in the process. In the last article of this series, "Thermodynamic Analysis of Oxygen-Enriched Direct Smelting of Jamesonite Concentrate," Zhong-Tang Zhang et al. intend to shed more light on the smelting of oxygen-enriched direct smelting of jamesonite concentrate from a combined theoretical and experimental view. They first gave a detailed thermodynamic analysis of oxygen-enriched direct smelting of jamesonite concentrate by considering the occurrence state of lead, antimony and other metallic elements in the smelting process through constructing corresponding predominance area diagrams. This was followed by an experimental verification test which indicated that the main phases in the alloy and slag contained metallic lead, metallic antimony, iron-antimony, copper-antimony, kirschsteinite, fayalite and zinc oxide. The great agreement between the theory and the experiment indicates that a similar approach can be used for driving future development of metallurgical processing of sulfide ores under external fields.

The following papers are published under the topic "Field-Intensified Metallurgy" in the December 2017 issue (vol. 69, no. 12) of *JOM* and can be accessed via the *JOM* page at http://link.springer.com/journal/11837/69/12/page/1.

- "Synthesis of Rutile TiO_2 from Panzhihua Sulfate Titanium Slag by Microwave Heating" by Hufei Chen, Guo Chen, Yunqi Wu, Jinhui Peng, C. Srinivasakannan, and Jin Chen
- "Arcmon for Process Control in Silicomanganese

Zhiwei Peng and Jesse White are the *JOM* advisors for the Pyrometallurgy Committee of the TMS Extraction and Processing Division, and guest editors for the topic Field-Intensified Metallurgy in this issue.

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Production: A Case Study" by Joalet Dalene Steenkamp, Christopher James Hockaday, Johan Petrus Gous, Wilma Clark, and Archie Corfield

- "Thermodynamic Analysis of Oxygen-Enriched Direct Smelting of Jamesonite Concentrate" by Zhong-Tang Zhang, Xi Dai, and Wen-Hai Zhang.

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