

New Technology of Unconventional Metallurgy

Jinhui Peng Libo Zhang Hongying Xia
Shaohua Ju Guo Chen Lei Xu



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非常规冶金新技术

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Preface

Unconventional metallurgy is a new technology developed in recent years, mainly focusing on major pressing issues of comprehensive utilization of mineral resources, energy saving and emission reduction, and deep processing of value-added metallurgical products in metallurgical industry, using modern technology to improve traditional metallurgical process, developing an efficient and environment-friendly new metallurgical reactor, deepening metallurgical theory and process under the outside fields and extreme conditions, obtaining the original innovations and intellectual property in the fields of unconventional metallurgy, enhancing the scientific and technological innovation in metallurgical industry, and promoting the leading role of the metallurgical industry on the national economy and social development. At present main research interests include; (1) novel technology of microwave metallurgy; (2) application of microwave technology in materials science and chemical engineering; (3) novel technology of ultrasonic metallurgy and micro-fluidics metallurgy.

As a green heating mode, microwaves heat materials directly through internal energy dissipation of materials, with advantages of selective heating, fast heat rate and high efficiency, and furthermore can lower the reaction temperature, shorten the reaction time, resulting in the energy saving and consumption reducing, is one of the effective way to realize clean production in metallurgical industry. So, it is of great importance to develop new microwave metallurgical technology. In recent years, the authors and members of the research group have conducted in-depth research on microwave metallurgy technologies, built up the microwave heating network models; determined the dielectric properties and temperature rising characteristics of metallurgical materials in microwave field, in-

investigated changes of material properties by microwave drying, reduction, calcining, roasting and leaching; and carried out the application of microwave new technology in materials science and chemical engineering, promoted the comprehensive utilization of the strategic non-ferrous metals refractory resources in China.

The cavitation effects, mechanical effects and thermal effects of ultrasonic can make the ultrasonic wave produce fast and intensive mechanic motion when propagation in a liquid, forming bubbles or holes, when the bubbles shrink rapidly, they would result in local high temperature and high pressure accompanied by an intense shock wave, promoting phase boundary and interface updating and disturbing, accelerating the heat and mass transfer, which has been widely used in metallurgical, chemical, solution purification and other fields. The authors and members of the research group investigated the typical metallurgical units of ultrasonic metallurgy, studying the leaching kinetics of zinc residue under ultrasonic field, and compared with conventional leaching process, showing that the ultrasound technique can make up for the shortcomings of traditional hydrometallurgy technology, strengthening the leaching process and reducing the processing time, is a new and effective way.

Micro-fluid metallurgical technology refers to techniques of control, manipulation and detection of complex fluids under the microscopic size, realizing the micro- and nano-level mixing, mass transfer and reaction in a micro-channel. The authors and members of the research group investigated the typical metallurgical units of micro-fluidic metallurgy, studying the extraction, separation of In, Fe and Zn by micro-fluids, realizing the separation of In and Fe, Zn, shortening the reaction time, and enhancing the security of the process; for the separation extraction of nickel and cobalt ions, the micro fluidic single-stage extraction efficiency increased more than 10%, total extraction stages can be reduced by 4 levels. Combined with the advantages of fast mixing mass transfer rate, reacting homogeneously, continuous stable of micro-fluidic technology, re-

alizing the continuous rapid preparation process of nano – powders through micro – channel mixing. Micro – fluidic metallurgical technology has been developing rapidly, promoting industrial upgrading of the metallurgical industry by using its advantages of high efficiency, low consumption and safety, to transform unit processes of the traditional metallurgical industries with disadvantages of low efficiency and high consumption, such as the extraction, heat transfer and mixing.

The book is divided into four chapters. The Chapter I discusses the application of microwave metallurgical technology in the drying, reduction, calcining, roasting, leaching, comprehensive utilization of the metallurgical material and process simulation of interaction between microwave field and materials; the Chapter II introduces the application of microwave technique in material science and chemical engineering, such as novel materials preparation by microwave sintering, and the comprehensive utilization of waste/spent catalyst and the regeneration of activated carbon; the Chapter III describes the effect of ultrasonic metallurgical technique on the process of zinc residue leaching and model of leaching kinetics; the Chapter IV introduces the application of micro – fluid metallurgical technique in the extraction separation and the synthesis of nano – powders. The book is informative, illustrated, reader – friendly and practical, not only has practical value, but also make it easier for the reader's understanding of new technologies and innovation.

Authors refer to a number of books and literatures in the process of writing the book, the authors pay the deep respect and gratitude to whom concerned the book and gave suggestions and comments. Special thanks go to the National Science Foundation of China, Fund of Ministry of Science and Technology and Ministry of Education, Yunnan Provincial Natural Science Foundation and Supports of Corporate. With these supports, the authors can carry out the uninterrupted research on unconventional metallurgical technique, and included the results in the book. This book was completed under the guidance of me and members of

the research group, the achievements of research group in the book are always impregnated with successive sweat and wisdom of doctoral students, graduate and undergraduate students, here, I would like to take the occasion of completing the book to give my heartfelt thanks to them.

The authors are aware that the expertise is limited and that there may be some errors in the book. If so, please do not hesitate to point them out.

Jinhui Peng
January 2015

About the Author

Jinhui Peng was born in December 1964 and got the doctor's degree from Kunming University of Science and Technology in 1992, then got to Germany and England for postdoctoral research from 1994 to 1996 and from 1999 to 2000, respectively. Now he is a tutor of Ph. D students in the field of non – ferrous metallurgy and chairman of the Key Laboratory of Unconventional Metallurgy, Ministry of Education, at the same time, he is foreign academician of Academy of Natural Sciences, Russia, and Institute of International Mineral Resources, meantime, he also enjoys the special allowance of the State Department.

Prof. Jinhui Peng has devoted himself to establishing the new technology of unconventional metallurgy, accomplished more than 70 projects of 973 Program, 863 Program, National Natural Science Foundation of China, International S&T Cooperation Program of China, Science Foundation of Ministry of Education of China, Key Enterprise Entrusted Brainstorm Project, etc. He has won many prizes of state technological invention award, science and technology innovation prize of Ho Leung Ho Lee foundation, award nomination for the top ten national excellent science and technology workers, outstanding contribution award for national science & technology during the “11th Five – Year Plan”, etc. In addition, **Prof. Jinhui Peng** is one of the sixth discipline appraisal group members of the state department, a subject matter expert for 863 Program during the “12th Five – Year Plan”, and one of reviewing expertise group members of post – doctoral research station. **Prof. Jinhui Peng** has published 4 books, more than 500 papers, and 160 patents.

As a project engineer, the research results achieved by **Prof. Jinhui Peng** are in the international advanced level. The group independently developed a series of new type of microwave high temperature device, and established some large – scale, continuous, and automatic microwave high temperature pilot lines, which are successfully used for material modification, waste comprehensive utilization, and metallurgical products, etc. , achieving the aim of high efficiency, energy saving and environment friendly.

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Chapter I

New Technology of Microwave Metallurgy



