Introduction

Sodium-ion batteries (SIBs) were discovered in almost the same era as lithium-ion batteries, and they even preceded lithium-ion batteries in some pioneering works. However, because of the limited theoretical capacity and sluggish reaction kinetics, SIBs have not made any breakthrough in theoretical research and practical applications for a long time. It was not until the late 1990s and early 2000s, with the development of layered transition metal oxide cathodes and hard carbon anodes, that SIBs came back into the limelight. For example, the Institute of Physics of Chinese Academy of Sciences, Wuhan University, Fudan University, University of Science and Technology of China, Beijing Institute of Technology, Wollongong University, Nanyang Technological University, Argonne National Laboratory, and foreign research institutions are devoted to the basic research of SIBs. In addition, domestic production enterprises represented by HINA BATTERY, NATRIUM, and STAR SODIUM have also made important contributions to the practical advancement of SIBs. In 2021, numerous investors made significant investments in SIBs, such as Hui Capital, Phoenix Tree Capital Group, Contemporary Amperex Technology Co., Limited, and Guangzhou Great Power Energy and Technology Co., Ltd are also building their commercial lines for SIBs.

Compared with the traditional energy storage system, SIB presents the advantages of low cost, easy availability for raw materials, green environment, safety and reliability, and combine the high energy density, power density, and long cycling life. For large-scale energy storage devices without site constraints and environmental restrictions, SIBs are ideal. In addition, SIBs enable broad application prospects in low-speed electric vehicles, home energy storage, electric boats, and other fields.

In recent years, breakthroughs have been made in research work on SIBs, covering cathode/anode materials, electrolytes, and full-cell assemble. Representative cathode materials include layered transition metal oxides, polyanionic compounds, and Prussian blue and its analogs; anode materials include carbon-based materials, titanium-based compounds, conversion compounds, and intermetallic compounds; electrolytes include organic electrolytes, ionic liquid electrolytes, high-concentration electrolytes, and solid-state electrolytes. The assembly and matching of full batteries

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involve the study of cathode/anode compatibility, and the development of finished full batteries, flexible batteries, and new devices. Meanwhile, testing and characterization technology have also greatly shortened the development time of SIBs. A series of advanced techniques such as spherical differential electron microscopy, synchrotron radiation, neutron diffraction, and solid-state nuclear magnetism have been used to study the sodium storage mechanism, interfacial evolution, and mechanical properties of electrode materials in depth. This book was written during the booming period of basic research and industrial applications for SIBs. In the next step, SIBs need to be studied from an application perspective, focusing on the interfacial compatibility of electrode materials and electrolytes, further solving the problem of sluggish reaction kinetics in SIBs and improving the cycling stability of SIBs.

During the preparation of this book, PhD students including Ziheng Wang, Jiahui Zhou, and Ying Jiang made important contributions to the writing of this book by combining their research work. Ditong Chu, Guangling Wei, Cheng Li, Yixin Zhang, Zehua Li, and Yutong Hao are the master students who have done a lot of literature collection, data compilation, and graph compilation in the process of writing this book. In addition, we would like to express our gratitude to Yutong Hao, Yaozong Zhou, Anni Liu, Yan Chen, and Zekai Lv, who contributed to the translation of this book.

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At present, SIB is in the stage of rapid development, and its research scope involves materials, physics, chemistry, and other multidisciplinary. Due to the limited knowledge and ability of the authors, there are inevitably omissions and deficiencies in this book, and we would appreciate the criticism of colleagues and readers.

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