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Introduction

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With ever-increasing concerns about limited fossil fuel reserves (e.g. oil, coal, and natural gas) and the environmental degeneration caused by the emission of harmful gases (e.g. CO_2 and SO_2), there is an urgent need to replace polluted unrenewable energy resources with clean renewable energy resources (e.g. wind and solar energy). Nevertheless, the generation of renewable energy is intermittent, and the electricity output is unstable. Harvesting renewably generated electricity using an electrochemical energy storage system is a practical way to address the intrinsic issues with renewable energy. In addition, removable electrochemical energy storage technologies play a huge role in our daily lives. For example, phones, laptops, and smartwatches we use daily are powered by high-energy-density lithium-ion batteries (LIBs). Some advanced vehicle manufacturing companies (e.g. BYD and Tesla) have launched electric vehicles, in an attempt to decrease harmful gas emissions. Nevertheless, the application of electrochemical energy storage technologies in a wide range of fields is still challenging. The properties of energy storage technologies depend on the applications and the market they are being used. For example, portable energy storage devices and energy storage systems used by people in their daily lives should be energy dense and highly safe. Outdoor energy storage systems in cold regions should possess good low-temperature energy storage performance. Energy storage devices used in regenerative braking should have both high energy density and power density.

To push forward the energy structure upgrade, numerous studies have been dedicated to the investigation of advanced energy storage technologies. Various promising energy storage technologies (e.g. high-safety solid-state batteries, aqueous lithium-ion batteries [ALIBs], aqueous zinc-ion batteries [AZIBs], high-energy-density lithium–sulfur batteries [Li-S batteries], metal–air batteries, and metal–CO_2 batteries) have been developed. These advanced energy storage technologies are designed for different requirements and markets and show

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promise for next-generation energy storage technologies. In this book, recent advances in energy storage technologies that can be commercialized are thoroughly summarized and discussed in detail, providing the landscape of the state-of-the-art electrochemical energy storage technologies and their widespread practical applications. First, the fundamental knowledge about energy storage technologies will be introduced, and then the practical progress of the existing commercial energy storage technologies and the corresponding energy storage properties, as well as critical challenges, will be presented. Subsequently, energy storage mechanisms, critical issues, design strategies, and practical progress of next-generation energy storage technologies will be discussed. Finally, future trends in these advanced energy storage technologies will be presented. We hope this book can contribute to the development of electrochemical energy storage technologies.