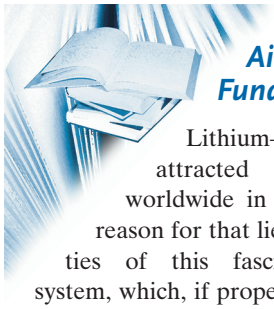

The Lithium Air Battery: Fundamentals

Lithium–air batteries have attracted considerable attention worldwide in the last few years. The reason for that lies in the intrinsic properties of this fascinating electrochemical system, which, if properly exploited, could lead to a power source with an energy density four to five times higher than that of the ordinary lithium-ion battery, with practical applications not only in the consumer electronics market but also, and most importantly, in key emerging ones such as electric road vehicles. However, some major issues, including the stability of the electrolyte, inefficient electrode kinetics, rate capability, corrosion of the carbon electrode, and limited charge–discharge energy efficiency, do not yet appear to be properly addressed. Although important breakthroughs have recently been achieved at the academic level, it is not yet clear whether the lithium–air battery could effectively fulfil its development potential. This book, a collection of chapters written by leading experts in the field, is a timely publication that examines the above-mentioned aspects, providing readers with a critical view of the relevance and prospects of this important technology.

The book opens with an introductory chapter which, after a brief summary of the history of batteries in general, begins the detailed discussion of lithium–air batteries by describing their initial development, their classification, which covers aqueous and non-aqueous electrolyte types, and the current issues and future prospects of both types.

The first part of the book is focused on non-aqueous types. Chapters 2 and 3 begin with a comprehensive review and discussion of the properties and characteristics of the most common non-aqueous electrolytes (Chapter 2) and of oxygen cathodes (Chapter 3). Typical organic carbonate electrolytes used in lithium-ion cells are discussed, and the reasons why they are unsuitable for the purpose are clearly explained. These chapters continue by providing a useful description of methods for determining the stability of a given electrolyte in the Li–O_2 cell environment. A wide range of electrolytes, including ethers, amides, sulfones, ionic liquids, and dimethyl sulfoxide are examined in Chapter 2, focusing on their pros and cons as battery media. The analysis is completed in Chapter 3 with a discussion of the theoretical aspects of the electrolyte decomposition process, as well as of the basic electrochemistry of the oxygen electrode, including kinetics and electrocatalysis. The kinetics analysis is then completed with great accuracy in Chapter 4, which would provide a very useful reference base for a researcher who planned to enter the field by investigating this important aspect. Chapter 5 is focused on a theoretical approach to the system, with a description and discussion of computational studies and of their relevance as key supports to the experimental findings.

The second part of the book is devoted to lithium–air batteries with aqueous or solid electrolyte systems. The practical importance of these types is emphasized by describing the expected advantages in terms of reliability and safety. In the former case (aqueous electrolyte), this is achieved by cleverly exploiting a lithium anode protected by a metal sheath, which allows the use of conventional electrolyte media. In the latter case, a solid separator assures stability and a relatively easy method of cell construction in a full solid-state configuration. In this fashion, Chapter 6 provides detailed information on the design of the primary and secondary aqueous Li–O_2 battery, and on the most promising materials that can serve as protective layers for the lithium electrode. Following that, Chapter 7 discusses the electrochemistry of the discharging and charging reactions and describes the structure and design of the air electrodes in solid-state lithium–air batteries. Fully solid systems are also described in Chapter 8, where the reader can find a useful list of the most promising solid electrolytes, including Nasicon and garnet types, as well as a detailed description of their synthesis and of their electrochemical characterization. The structure and performance of solid-state batteries is discussed in Chapter 9. The lithium–air panorama is concluded with an exhaustive description of primary systems (Chapter 10), and with a final overview (Chapter 11) focusing on the issues associated with oxygen handling and storage in relation to the possible practical development of the Li–O_2 battery.

Overall, this is a very nice and useful book that can be regarded as a valuable reference source for the lithium–air research and development community, either those who are already involved in the area or wish to get into this challenging field.

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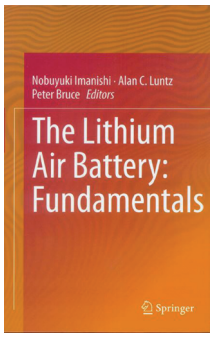

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