Preface

Supercapacitors may be poised to become the dominant technology for electrical energy storage, particularly in applications requiring long cycle life, durability, and rapid charge transfer. If so, history tells us that end-use applications will be developed to drive increasing levels of electrical power through them, resulting in unwanted thermal effects. Thermal management is likely to become an important issue that affects supercapacitor performance in practical applications. Knowledge of thermal stability of different components (e.g., electrodes, electrolytes, and separators) will aid in the design of supercapacitors that operate with high functional performance over wide temperature ranges. Thermophysical properties of these components (particular electrolytes) significantly affect the thermal behavior of the overall devices. This monograph attempts to provide a broad coverage on the current state of knowledge of such issues.

In this work, thermal issues of supercapacitors are discussed from both experimental research and theoretical perspectives. In Chap. 1, we provide a brief introduction to thermal management in common electrochemical energy storage systems such as supercapacitors, lithium ion batteries, and fuel cells. Thermal characteristics of the major electrochemical energy systems are compared. In Chap. 2, we review thermal considerations for supercapacitors including thermal management approaches in different applications, mechanisms of thermal transport, experimental techniques for thermal characterization, and performance metrics. This chapter paves the way for those following, which address more specific thermal influences on supercapacitor components and performance. Chapter 3 considers the effects of temperature on thermophysical properties of the supercapacitor components including electrolytes, electrodes (active electrode materials, current collectors, and binders), and separators. In Chap. 4, we investigate the influence of temperature on electrochemical performance of integrated supercapacitors primarily through two crucial metrics—capacitance and ESR—and also others such as aging, self-discharge, and leakage. In Chap. 5, thermal models to analyze thermal behaviors of supercapacitors are discussed. And finally, we draw conclusions and highlight future research directions in Chap. 6.

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