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Preface

Energy storage by rechargeable batteries has come to occupy a central stage in the last couple of decades, because of the ubiquitous availability of internet-based devices such as laptop computers, smartphones, computing tablets, digital cameras, and e-book readers.

The importance of batteries has been further augmented because of their use in power tools and a variety of other portable devices including those used in tele-medicine and tele-learning and in other needs of instant communication. And finally, the drive to replace fossil fuel based cars, buses, etc. by hybrid vehicles and electric vehicles has pushed the crucial role of these batteries to the societal forefront where the conjuncture of energy and environmental issues is the most vital concern.

In this context, the research, development, and commercialization of increasingly more efficient and durable batteries of higher energy and power densities have led to an immense field of intense activity. The number of published papers and patents is staggering with a concomitant vast industrial activity on a variety of batteries, especially those based on lithium.

Countless symposia and conferences have been devoted to this field. Also, over the years, a number of excellent books have been published, mostly edited volumes containing chapters by leading workers in the field.

Thus, the question arises, why another book on batteries? There are different reasons: First, a major center of pure and applied research on modern lithium batteries has formed at Hydro-Québec Research Institute, which employs the authors of this book: we wish to present the field in terms of our experience and understanding of this subject. Second, the previous books have been written by battery scientists; the backgrounds of the present authors, however, permit a look at this area through different prisms: Christian Julien and Alain Mauger are solid-state physicists working on the materials aspects of batteries; Ashok Vijh is an interfacial electrochemist who is new to this field and thus has a different perspective; Karim Zaghib is trained as a electrochemical engineer and has a vast experience in battery science and technology. Third, the battery fires experienced not only in ground

transport but also in air transport give us the proof that the warnings of the scientific community have not been heard, or have not been taken into consideration by the commercial car and plane companies in charge of the implementation and the choice of lithium-ion batteries. The present authors, among others, have discussed these safety problems in different scientific reviews that obviously were not read by the engineers in the Procurement department and in charge of the management of these companies. In this context, we felt useful to focus more attention on the safety aspects in a book that is also intended to reach a broader audience in the industrial community than the scientific reviews.

Fourth, important progress in the laboratories has been made in the last 4 years in the nanotechnology to synthesize porous nanoparticles and/or prepare composites of nanoparticles with a conductive element such as graphene or carbon nanotubes, or by nano-painting the particles by a conductive layer. Some of these techniques are scalable, and we hope that they will permit the development of a new generation of Li-ion batteries in a very near future. One goal of this book is also to inform the reader of this advance in research and discuss the scaling aspect.

Finally, we wanted to write a book that emphasizes the materials aspects, both their bulk and interfacial properties, as distinct from many other aspects of battery technology. Thus this book reflects our belief that any future progress in the further study of batteries will be based on the fundamental physicochemical aspects of battery materials. In this context, it is not out of place to point out here that even in the past, the major strides in lithium batteries were also based on a fundamental understanding of the physics and chemistry of battery materials: the supreme example of this approach is the work of John Goodenough.

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