

Advances in Lithium-Ion Batteries

Edited by Walter A. van Schalkwijk (University of Washington, Seattle)

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The editors state in their introduction that this book is intended for lithium-ion scientists and engineers but they hope it may be of interest to scientists from other fields. Their main aim was to provide a snapshot of the state of the Lithium-ion art and in this they have largely succeeded. The book comprises of a collection of very current reviews of the lithium ion battery literature by acknowledged experts that draw heavily on the authors' own research but are sufficiently general to provide the lithium ion researcher with enough guidance to the current literature and the current thinking in the field. Some of the literature references may be too current as there are numerous citations of conference proceedings which may be easily accessible to the lithium ion scientist or engineer but are not likely to be available to the interested chemist coming to the field for the first time. One author expresses the hope and expectation that properly peer-reviewed articles will appear in due course and the interested reader should look out for them in future.

From the point of view of the lithium ion battery scientist and engineer, the book covers most of the topics that are of current interest. Two areas are treated by inference in the various chapters but are not specifically granted chapters of their own. One of these is safety and abuse tolerance and the other is cost. Since there are a number of groups active in the investigation of abuse tolerance of these batteries this is a curious omission and obviously the cost factor is a driver for commercial development. Some more explicit treatment of these topics might have been appropriate.

The book should be instructive to the chemical community provided the average chemist can obtain some guidance from an electrochemist or battery engineer. Many of the measurements and techniques referred to (e.g. impedance, capacities, etc.) may be somewhat unfamiliar and confusing in the context they are used. Chemists who persevere and can obtain some guidance will find some rich opportunities for the application of analytical, inorganic and organic chemistry to unravel some of the puzzling mysteries of lithium ion batteries. The book begins with an extended chapter on the crucial role of the surface films on electrodes which provides an excellent introduction to the state of thinking in this field. This work is a tour de force in the application of surface analytical techniques and clearly demonstrates some of the shortcomings in the mechanism development. Several other chapters also provide ample evidence of opportunities for mechanistic determination and the chemist may be left with a rather alarming impression of a very unstable electrolyte system. However, the chapter on surface films will sound familiar to any chemist who has suffered the vagaries of a recalcitrant Grignard reaction. Since the operation of these surface films is of such importance to lithium ion batteries one is amazed that their formation appears to be left to serendipity. Clearly, there are great opportunities here for imaginative chemists and engineers.

One is struck by the contrast between the modeling chapter and many of the descriptive chapters. The modeling work only addresses continuum models but is extremely rigorous, requiring accurate quantitative measurements while much of the phenomenological chapters is very qualitative in nature. The modeling coverage does not include molecular dynamics for ion transport nor does it include *ab initio* calculations for chemical reactivity although there is much activity in the chemical literature. This is

disappointing for the chemist but probably is a reflection of the gap between practice and theory, particularly in the area of electrolytes. The chapters on electrode materials are rather short in comparison to those on electrolytes and interfacial phenomena, perhaps reflecting the more mature knowledge base in these areas.

There are chapters on scale-up, manufacturing techniques and charging and monitoring that provide useful perspectives for some of the choices of materials that go into lithium ion batteries. The chapter on aging summarizes the effects of the chemistry on the battery performance although this is one area where the newcomer to batteries might need a lot of interpretation and guidance. This chapter illustrates the use of empirical modeling to predict lifetime and also demonstrates where the development of a more quantitative database on the chemical reactivity would be invaluable. This would be a fertile area for physical organic chemists. Also of interest to chemists is the description of ionic liquids as electrolyte which open new opportunities for new electrochemical couples as exemplified by Scrosati's chapter on low voltage systems. The descriptions of the polymer gel systems should also provide indications to polymer scientists as to where their skills are needed to facilitate the development of the technology.

The book does this for most aspects of the system chemistry with a couple of exceptions and is definitely a valuable snap-shot of the state of the by no means finished art of lithium ion batteries. However, there are numerous grammatical errors which are a nuisance and distracting. Perhaps a little more careful editing would have been helpful.

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