

Preface

The amount of research activity in the hydrogen storage field has increased substantially over the last decade or so, primarily due to the practical need for a hydrogen storage method suitable for use in hydrogen fuel cell cars and other hydrogen-based transportation technology. Hydrogen can store a large amount of chemical energy per unit mass but under ambient conditions it exists in its pure form only as a low density gas. As a consequence, a number of studies have identified the problem of storing hydrogen, for use as a fuel, as a major obstacle to the smooth transition from a fossil fuel-based transportation system to one in which hydrogen is the principal energy carrier. This so-called hydrogen energy transition is seen by many as the answer to the numerous problems associated with our current reliance on oil, which include its finite nature and issues such as energy security and climate change. The international effort to accelerate this transition is well underway, with the recent introduction of the Honda FCX Clarity, the first production hydrogen fuel cell car, leading the way towards wider commercialisation of hydrogen fuel cell technology by the automotive industry. However, the practical problems of fuel cell durability and cost, and effective hydrogen storage, still exist. In the case of the latter, the storage of hydrogen in a solid state material is a very promising potential solution, and the discovery or development of a highly efficient reversible hydrogen storage material would therefore mark a step change in the transition to a hydrogen-fuelled future.

Reversible hydrogen storage materials tend to be either hydrides or microporous adsorbents. A number of books are already available on metal hydride materials, as well as others that cover the use of gas adsorption measurement for the characterisation of porous adsorbents. The former tend to focus on metal-hydrogen system properties, whether thermodynamic, magnetic, crystallographic and so forth, and the latter on the characterisation of the porous structure or surface area of porous materials and powders using the adsorption of gases other than hydrogen. In addition, in the last year or so, undoubtedly due to the recent increase in the level of interest in hydrogen energy, a handful of books have been published with solid state hydrogen storage as their main focus; however, none of these have yet dealt specifically, from a practical point of view, with the characterisation of

the hydrogen storage, or hydrogen sorption, properties of candidate media. The importance of this is clear because without high accuracy characterisation it is not possible to effectively assess the storage capabilities of a material and hence make a meaningful comparison with other potential candidates.

However, the practical measurement of hydrogen uptake and release, particularly for storage applications, can be technically demanding, due mainly to the physical properties of hydrogen, but also to the high pressure measurement conditions required for hydrogen storage applications and the sensitivity of many of the materials to contamination of one form or another. Although this aspect of hydrogen storage material research has been partially addressed by some of the recent books on the topic, it is not their main focus and measurement accuracy is not treated in detail. This book is therefore an attempt to provide a monograph on this important aspect of hydrogen storage material research. Coverage of the various types of hydrogen storage material is included for completeness, along with some of the common complementary characterisation techniques used in the field. It is hoped that it will be of practical use as an introduction to relative newcomers to the field, while also acting as a useful reference source for experienced hydrogen storage material or hydride researchers. In addition, although the main motivation behind this work is the current search for a material suitable for storing hydrogen for use as an energy carrier, it is also hoped that much of the content will be of interest to those studying hydrogen absorption or adsorption by materials for many other practical applications, as well as for scientific interest.

The basis for much of the content, in particular [Chap. 6](#), which covers error sources and issues affecting measurement accuracy, was prepared during a three year postdoctoral period spent at the European Commission's Institute for Energy in the Netherlands. The remainder has been completed whilst I have been employed by Hiden Isochema Ltd in the UK. However, any views or opinions expressed are entirely my own and I also take full responsibility for any inaccuracies contained herein. I hope that the book is useful for those with an interest in the subject and would very much welcome any feedback or questions regarding any of the topics or issues covered and discussed (darrenbroom@inbox.com).

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