Cover Profile
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Developments in Dilatometry for Characterisation of Electrochemical Devices


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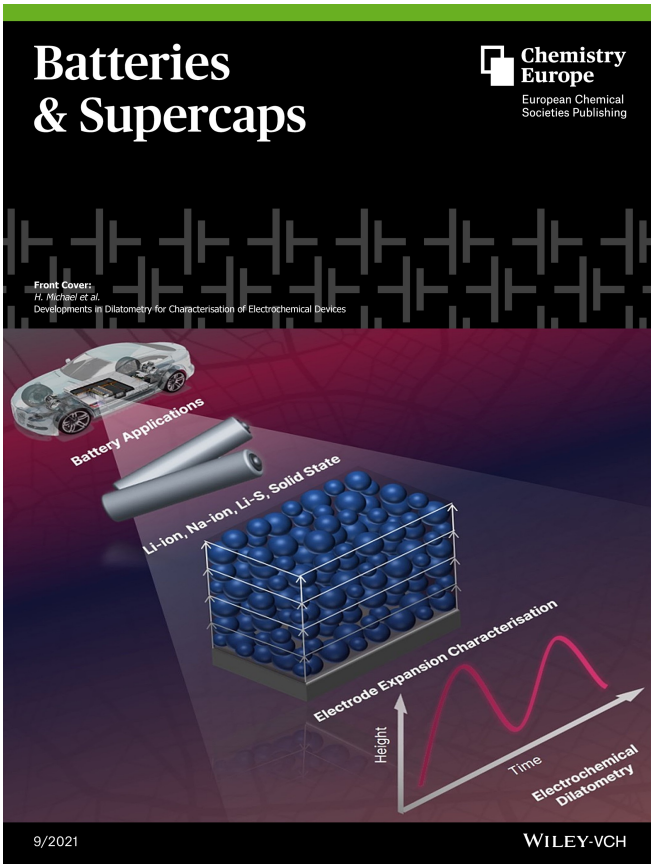
Invited for this month's cover picture is the group of authors from The Electrochemical Innovation Lab at University College London and The Faraday Institution. The cover picture shows how electrochemical dilatometry can inform real world battery applications through the study of electrode expansion characterisation of various battery chemistries. Read the full text of the Review by H. Michael et al.

What prompted you to investigate this topic/problem?

Lithium-ion batteries (LiBs) have electrodes that undergo volume changes during cycling; over long term operation, this can result in particle cracking and electrode degradation. Understanding how commonly used electrodes and next-generation candidate materials dilate and degrade is therefore of critical value in improving electrode durability and overall battery performance. In recent years, there has been a plethora of studies using electrochemical dilatometry (ECD) as a monitoring tool for understanding operating performance in various electrochemical devices; however, to our knowledge, there has been no in-depth review of this body of research to date.



What do you consider the exciting developments in the field?

An exciting development in this field is the various dilatometer instruments that have been designed and have become commercially available with resolution capabilities spanning tens of microns down to a few nanometres. The use of dilatometry for research in electrochemical devices has been so ground-breaking that it has prompted further advances in dilatometer instrumentation design. For instance, design features have been altered to allow measurement of thickness variations in solid-state battery chemistries and resolution capabilities are being continuously improved.

What future opportunities do you see (in the light of the results summarized in this review)?

The opportunity to use ECD to study thickness variations and thus better understand the mechanical durability of next-generation anode and cathode materials for LiBs. There is a growing consensus of the need to migrate from the current state-of-the-art layered NMC cathodes to stoichiometries with lower cobalt content, and increasing use of high capacity alloying materials, such as silicon, at the anode. Dilatometry can be used to evaluate novel electrode compositions in LiBs as well as electrode materials for next generation chemistries such as sodium-ion and Li–sulfur batteries.

What other topics are you working on at the moment?

We are also assessing acoustic techniques as a diagnostic tool for monitoring degradation mechanisms in LiBs such as gas formation and thermal expansion. Measuring the thickness variations of Li-ion cells during various cycling protocols facilitates a multi-scale approach to evaluating the dimensional changes of LiBs. The aim is to complement the information obtained from ECD with acoustic techniques and reveal physical changes that can be detected and cross-correlated using both techniques.