Batteries & Supercaps

Editorial
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Special Collection

Batteries & Supercaps: In Situ and Operando Methods for Energy Storage and Conversion

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Environmental concerns have pushed energy storage technologies toward higher sustainability and efficiency, and functional materials must evolve to meet these demands. This **Special Collection** concerns the recent evolution of methods and techniques used to understand the function of such materials, a necessary step towards the rational design of new energy storage technology with improved performance characteristics.

Such characterisation methods would ideally give information about energy storage materials and components that are performing as they would in the operating device, as close to real-world applied conditions and with as much detail as possible. Even though it is often necessary to adapt the system being studied to the specific constraints of a characterisation tool to obtain detailed or high quality information, recent advances in instrumentation and methods are bringing us closer to being able to examine materials under representative real-life operating conditions. Such analytical approaches, which are also known as "in situ" and "(in) operando" methods, can provide unique insights on materials function under energy storage and delivery cycling conditions and are becoming increasingly popular in energy materials research. Both the number of available techniques applied to understand function of materials within working devices as well as the energy and spatial resolution gained by these techniques are growing. This Special Collection is devoted to these methods and features works highlighting such approaches as applied to electrochemical storage devices.

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Special Collection *This Editorial is part of a joint Special Collection between Batteries & Supercaps and Chemistry–Methods on In Situ and Operando Methods for Energy Storage and Conversion*

While some works in this Special Collection highlight recent developments in the in situ and (in) operando characterisation techniques that have been successfully applied for more than a decade, such as X-ray and neutron diffraction and X-ray spectroscopy (**Liang et al.**, **Wu et al.**, **Gustafsson et al.**, **Chien et al.**, **Lebens-Higgins**), some new rising methods such as acoustic emission methods (**Schweidler et al.**), online gas analysis (**Sångeland et al.**, **Ab-El-Latif et al.**), dilatometry (**Michael et al.**), and terahertz spectroscopy (**Krotkov et al.**), provide complementary information of the evolution of materials within systems, particularly regarding important insights into materials degradation mechanisms.

Because instrumentation and techniques have advanced faster than terms used to describe many of these methods, we do not yet have an agreement within the community on language used to discuss these characterization conditions. The International Union of Pure and Applied Chemistry Committee "Recommendations for terms relating to materials characterization: Latin and other introduced terms" aims to clarify and resolve discrepancies for terms describing materials characterization, particularly for

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non-ambient conditions, within systems, and during change, as relevant for energy storage materials. The project committee invites you to contribute to this project and seeks input in particular into reviewing the list of terms used to describe sample characterisation conditions. To get involved, please see details at: https://iupac.org/projects/project-details/?project nr=2021-009-2-500.