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Editorial: Establishing standards for battery data and pathways towards its validation

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Editorial on the Research Topic
Establishing standards for battery data and pathways towards its validation

The collection and analysis of data plays a key role in the life cycle of a battery; from the discovery of new materials and components to the evaluation of cell performance and safety, battery data is an enabler of innovation. As with most areas of scientific research, the ability to share and leverage data across a field of researchers leads to accelerated learning, deeper understanding, and ultimately expediated technology maturation. Standardization of data acquisition, analysis and storage creates a data ecosystem which readily informs battery management systems, lifetime prediction models and ultimately the design of future experiments and technologies. This Research Topic highlights the benefits of standardized battery performance data collection, by:

- Promoting accurate assessment and/or comparison of emerging battery or cell technologies
- Supporting the proliferation and sharing of actionable data to maximize utilization amongst researchers through open access data repositories
- Providing organized data for training and developing AI/ML models
- Highlighting the strengths and weaknesses of emerging cell chemistries and tracking improvements in cell build quality
- Informing optimal operating conditions and battery management system parameters

Prior efforts towards standardization, namely, those led by Idaho National Laboratory, have been successful to meet the objectives of the USABC (USABC, 2020) and most recently the U.S. Federal Consortium for Advanced Batteries (FCAB, 2021). These efforts have provided researchers a technology development envelope to work within in the absence of hard battery requirements. In the case of the USABC these protocols are application-specific, for hybrid and electrics vehicles, while application-agnostic in the case of the FCAB testing protocols. The Research Topic, "*Establishing Standards for Battery Data and Pathways towards its Validation*," attempts to build upon this existing framework and to emphasize

how standardization of battery data collected in academia and industry, when shared broadly, can accelerate global battery research and development.

The intelligent generation, utilization, and management of data resources is vital to the optimization of R&D processes. The effect of well-managed open access data stores is evident from previous research efforts, such as the human genome project, which had broad and far-reaching impacts on the field of genomic sequencing. Battery R&D also stands to benefit from more efficient data utilization, however realizing this goal requires standardization on multiple fronts.

High-quality data is essential to the accurate assessment and comparison of battery technologies. Standardized testing procedures and even test fixtures are recommended to minimize error and outside influence while also accounting for remaining factors which may impact the experiment. Testing procedures should additionally be designed to characterize cells without bias towards any cell-type or configuration. For each condition and purpose, cells should be fully characterized in terms of diverse output variables such as capacity loss, resistance changes, electrode degradation, etc. By evaluating cells under a diverse range of scenarios, unsafe or degradative conditions can be accurately accessed and identified thus informing optimal battery operation and the design of battery management systems.

After high-quality data is generated, it is crucial to promote sharing and proliferation of those resources to both academic and industrial communities. Open-source repositories of battery data can aid the broader research community in moving forward more rapidly by creating a positively reinforcing feedback loop where new data generation increases the rate of future data generation. Open access data stores allow disconnected individual groups to benefit from the aggregation of data and elucidate insights previously unavailable through smaller, siloed datasets. The intelligent design of those data stores can also enable insights to be drawn from the combination and relation of heterogenous data streams (i.e., cycling data and microscopy data, etc.). Well-designed data management further accelerates research and development by reducing the time needed for researchers to clean, filter, relate and analyze, large, diverse datasets.

Large-scale data repositories additionally provide a fertile training ground for machine learning-based remaining-useful-life, state-of-health, and state-of-charge prediction models. The use of accurate and complete datasets enables researchers to produce prediction models which cover a greater range of scenarios with fewer errors. Enhanced modeling capabilities also aid the characterization of degradation modes which further inform safe and optimal battery operation. Experimental times can additionally be reduced through modeling battery designs, materials, and electrolytes beforehand to swiftly identify which technologies have the highest chance of success.

As new cell chemistries and configurations are produced, there is a need to benchmark those emerging technologies fairly and accurately against previous cell types. Standardized battery data collection and management expedites this process through the creation of more homogeneous data. With datasets that are easily comparable, researchers can develop a clear understanding of a cell's strengths and weaknesses. Through this understanding, emerging battery technologies can be matched with applications that suit their unique performance profile. The ability to quickly identify suitable applications will thus promote and accelerate the adoption of emerging battery technologies.

This Research Topic consists of seven original research and methods papers highlighting the importance of standardizing battery data collection, organization and sharing. These papers highlight best practices for: standardized testing methods (Dubarry and Anseán; Dubarry and Anseán; Weng et al.) standardization of data structure (Lininger et al.) utilization of standardized data (Tarar et al.; Schauser et al.; Yao et al.) and leading concepts on battery data validation (Gering et al.)

Author contributions

DH: Conceptualization, Writing–original draft. ED: Conceptualization, Writing–review and editing. PM: Conceptualization, Writing–review and editing. TS: Conceptualization, Writing–review and editing. CL: Conceptualization, Writing–review and editing, Supervision, Writing–original draft.

Conflict of interest

Author DH is employed by Excet, Inc. a support contractor based at the U.S. Naval Research Laboratory. Author TS is employed by Voltaiq, Inc.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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