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Editorial: Thermal management of electrochemical energy devices or systems

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Editorial on the Research Topic
Thermal Management of Electrochemical Energy Devices or Systems

In the past year, we launched a Research Topic entitled *Thermal Management of Electrochemical Energy Devices or Systems*, and it is our pleasure to summarize the main findings in these accepted articles.

Thermal management is of primary importance in affecting the capacity fade (performance loss) of Li-ion batteries in electric vehicles (EVs). Carnovale and Li investigated several thermal management methods/strategies on the capacity fade of Li-ion batteries using a validated integrated electrochemical-transport-thermal model, which includes three sub-models: battery performance model, degradation model and thermal model. The solid-electrolyte interface (SEI) film formation and growth and active material loss in the electrodes were considered in investigating the degradation Research Topic. They found that the temperature has a determinative influence on the battery capacity fade and it can be effectively controlled by adopting proper thermal management methods/strategies for heat dissipation, which is much more effective when the battery temperature is close to 20°C (also the optimal battery operation temperature) and can increase the battery lifetime by as much as 25%. Moreover, lower charge voltage induces less capacity fade over cycling.

Flow fields play a significant role in affecting the performance of all-vanadium redox flow battery by promoting the uniform distribution of the electrolyte into the electrode and reducing the pumping power. Currently, the most common flow field configurations are serpentine flow field (SFF) and interdigitated flow field (IFF), but the superiority of SFF and IFF is unclear, which is affected by a variety of parameters. Duan et al. investigated the performance characteristics of flow batteries with IFF and SFF under various electrode parameters and operating conditions. It was found that the battery with IFF exhibits lower pressure drop and pumping power because of the shunt effect of IFF. However, the SFF outperforms IFF in promoting the uniform distribution of the electrolyte when the electrode porosity is higher than 810, but it is reversed when the electrode porosity decreases to below 714, indicating that there may be a performance reversal between SFF and IFF at different electrode porosities. Moreover, the current density, electrolyte input, and electrode thickness also lead to performance reversal at low electrode porosity. These findings explain the debate on the superiority of IFF and SFF in previous studies.

As the main energy source of solar-powered vehicles, the output of photovoltaic cells during cruise has attracted attention. This work (Li et al.) is based on a photovoltaic cell equivalent circuit model and a thermodynamic model. Taking the impact of the environment on the output of photovoltaic cells into account, the influence of wing surface temperature, flight altitude, flight time, and solar radiation is of primary concern. The surface temperature, variation of output voltage, current, and power are studied. The change of the photovoltaic cells output was discussed with the altitude changing from 0 to 35 km and time from 0 to 24 h in spring equinoxes, and the findings can be applied to study energy generations and flows of solar-powered vehicles.

Zhang et al. explored the influence of three different numbers of turns in the zigzag flow channels on the performance of proton exchange membrane fuel cell (PEMFC). Specifically, they analyzed the polarization curves, the molar concentrations of oxygen and water, and the power density of the flow channels with turns of 3, 6, and 9, and revealed that the overall performance of PEMFC with zigzag flow channels is much better than that with the conventional straight flow channel. With the increase of turns, the output power density of PEMFC with zigzag flow channels is also improved due to enhanced gas supply capacity. In addition, both the low oxygen concentration area and the molar concentration of water in the channel decrease. However, it should be noted that due to the relatively large resistance of the zigzag flow channels, the pressure drop and pumping power density gradually increase as the number of turns in the zigzag channel increases.

Using metal foam material with high porosity as flow field is an attractive route to improve the performance of open-cathode proton exchange membrane fuel cell (PEMFC) owing to its good gas distribution properties and gas permeability. Wang et al. analyzed the effect of metal foam structure parameters (pore density, thickness, compression ratio) on cell performance and mass transfer. Polarization curves and electrochemical impedance spectrum (EIS) results show that as the metal foam pore density increases, the cell performance increases firstly due to the increased pressure drop and then decreases for the reduction of reactants flowing into the reaction zone. Correlation analysis also reveals that increasing the thickness of the metal foam can improve the fuel cell performance, but the compression ratio of the metal foam has little effect. They also point out that the cell performance can be further enhanced by optimizing the structural parameters of the metal foam, which makes the metal foam a promising flow field for future open-cathode PEMFC with high power density.

Author contributions

ZQ wrote the draft manuscript, and the other authors discussed and revised the manuscript.

Conflict of interest

The 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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