



Challenges and Opportunities in Electrochemical Technology

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As we approach 50 years since Carl Wagner's 1962 treatise on "The Scope of Electrochemical Engineering" (Wagner, 1962), numerous authors have reflected on the history, status, and perspective of the discipline (Wendt and Kreysa, 1999; Bebelis et al., 2013; Walsh, 2019). Indeed in a recent perspective Prof. Mark E. Orazem paused to reflect on the question "What do electrochemical engineers do?" (Orazem, 2020). This milestone provides an opportunity to reflect on and celebrate the extensive influence of electrochemical engineering in modern society and consider both the breadth and depth of the discipline. Electrochemical engineers have had profound impact on areas spanning commodity chemical production, corrosion, catalysis and energy conversion, and storage. Moreover, the constantly evolving *shape* of the discipline requires constant evaluation of the growing influence and impact of electrochemical science and technology.

At its heart, the fundamental principles of electrochemical engineering remain the confluence of electrochemical reaction and mass transport phenomena. Beyond the scope of regular "reaction engineering" an electrochemical engineer must consider the interplay of current and voltage in addition to the wider considerations of kinetic, thermodynamic, and transport processes. This basic understanding informs a framework that can be applied to a broad range of materials and devices from micro-batteries to large scale aluminum production facilities, spanning micro-watt to mega-watt scales. Prof. Frank Walsh writes in his seminal text on the subject that "Electrochemical Engineering involves the design, characterization and operation of components, devices and processes which involve the interconversion of chemical and electrical energy" (Walsh, 1993). This elegant description encapsulates the discipline, although its brevity belies the many avenues of endeavor to which the electrochemical engineer has contributed.

A hallmark of the field is its multi-disciplinarity, not only bringing together electrochemists and chemical engineers, but also routinely engaging materials scientists, chemists, physicists, and electrical engineers. As a wider discipline, chemical engineering is under-going a re-birth; central to this is the theme of multi-disciplinarity. The days where undergraduate chemical engineers would default to careers in the oil and gas or process industries have gone, and there is growing recognition of the role of chemical engineers across a range of sectors, and in particular their key role in meeting aggressive targets for decarbonization.

It is highly appropriate that an ambitious and forward-looking journal such as *Frontiers in Chemical Engineering* embrace these changes and reflect the zeitgeist of our evolving discipline. "Chemical engineering ... offers unparalleled opportunities to address grand challenges facing society" and electrochemical engineering is at the vanguard of this. It is therefore with great pleasure that we are launching a specialty section on *Electrochemical Engineering* to complement the growing list of themes of the wider journal family.

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The section will encompass a breadth of electrochemical engineering themes, as outlined in the scope; these include, but are not limited to:

- Energy storage
- Energy conversion including fuel cells
- Membrane technologies and water purification
- Corrosion
- Electrochemical reaction engineering
- Electrochemical reactors: current distribution, fluid flow, mass transfer, and kinetics
- Electrochemical deposition
- Modeling electrochemical processes
- Electro-catalytic processes and photo-electrochemical processes
- Membranes: electrochemical processes, water purification
- Electrochemical synthesis and Electrowinning
- Electrochemical Sensors

These themes embody the cornerstones of transport phenomena, current distribution, kinetics, and thermodynamics central to electrochemical engineering. Whilst other outlets for work of this nature exist in isolation, we intend to provide a forum to consolidate and promote electrochemical engineering approaches which can be often overlooked.

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Our ambition for the growing editorial board is to reflect the diversity of the electrochemical engineering community in every sense. We seek to provide a forum to champion electrochemical engineering, to provide a rigorous, peer-reviewed outlet for cutting edge research that embraces the open-access philosophy of the Frontiers journal family, and to provide thought leadership for the community through review and perspective articles.

Led by our editorial board, thematic collections will be central to this ambition, and will provide a focal point for deeper investigations of specific technology spaces; however, as we aim to be a voice for the community, we welcome all contributions within the journal scope, and indeed encourage feedback from our readership to guide and finesse the shape of the journal to best reflect the current state-of-the art. On behalf of the editorial board, it is my great pleasure to start the journey in establishing the Electrochemical Engineering section and I look forward to welcoming your contributions.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

Conflict of Interest: The author declares 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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