Maynooth University
National University of Ireland Maynooth

Academic Supervisor Looking for an Industry Partner

Sustainable Flow Electrochemical Synthesis for Scalable Functionalisation of Bioactive Molecules

Area of Science: Chemical Sciences (Synthetic Chemistry and Process Engineering)

The chemical and pharmaceutical industries face increasing pressure to adopt sustainable and scalable manufacturing methods. Conventional synthesis relies on hazardous reagents, metal catalysts, and energy-intensive processes, resulting in high costs, regulatory burden, and environmental impact. Electrochemical synthesis offers a promising alternative by using electricity as a clean reagent. However, current approaches remain limited by poor scalability, inefficient reaction control, and challenges in translating laboratory methods to continuous manufacturing. This is particularly relevant for pharmaceutical manufacturing and API production, which are major industrial sectors in Ireland.
This project develops a next-generation electrochemical synthesis platform by integrating Alternate Electrode Electrolysis (AEE) with continuous flow systems. This enables efficient, scalable, and low-waste production of bioactive molecules and functionalised compounds relevant to pharmaceutical and fine chemical industries.

The approach focuses on:

- Continuous electrochemical activation using AEE to improve reaction efficiency and current utilisation
- Flow-based reactor systems to enable scalable, continuous manufacturing
- Optimised process conditions to enhance yield, selectivity, and reproducibility

The system is designed to be scalable, energy-efficient, and compatible with industrial process requirements, enabling transition from batch synthesis to continuous production.

Industry Relevance
The project directly addresses:

- need for greener and safer synthetic processes
- demand for scalable and continuous manufacturing technologies
- pressure to reduce waste and energy consumption in chemical production

It enables:

- replacement of hazardous reagents with electricity-based processes
- continuous production of high-value chemical intermediates
- reduction in operational costs and environmental footprint

Expected Outcomes

- Scalable electrochemical flow reactor platform
- Sustainable synthesis routes for bioactive molecules
- Reduced waste generation and energy consumption
- Improved process efficiency and reproducibility

Industry Mentor Role

- Provide input on industrial process requirements and constraints
- Guide application areas in pharma and fine chemicals
- Offer periodic advisory feedback (low time commitment)

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