

Electro-Organic chemistry in action: processes and products

Using electricity — the cheapest and greenest source of electrons — electrolysis represents a powerful tool to perform controlled redox reactions. By means of this approach, electrons act as traceless redox equivalents, enabling tight selectivity while often avoiding the use of hazardous oxidants or reductants and minimizing the generation of undesired by-products.

Electro-organic chemistry (a.k.a. molecular electrochemistry (ISE Division 6, www.ise-online.org) allows the *in situ* generation of highly reactive intermediates such as radicals, radical ions, and metal catalysts in specific oxidation states. These species, formed within the electrochemical cell, can either react there directly or be transported externally through flow chemistry to transform target substrates in a controlled manner. Careful selection of the electrode potential, combined with the exclusion of external oxidants or reductants, enables fine control over reaction selectivity. The wide range of accessible potentials makes electrochemistry uniquely capable of both activating low-reactivity molecules and precisely modulating the chemo-selectivity of functional group transformations.

Hence, this method opens access to one-electron disconnection strategies, significantly expanding the synthetic toolbox and reducing the need for protecting groups. Furthermore, the possibility to operate under mild conditions minimizes energy consumption, making electrochemical procedures a promising approach for more sustainable and efficient synthetic processes.

During the first year, this project will focus on electro-organic synthetic methods and suitable experimental set-up for aryl–aryl couplings to yield bi-aryl and poly-phenylene structures. The methodology will then be extended to heteroaryl–aryl couplings, specifically targeting thiophene–arene systems, to generate electroactive conjugated π -systems for protection and functionalization of metallic electrode surfaces. Once deposited onto the electrodes, these materials will undergo comprehensive characterization using advanced electrochemical, surface analysis and *in situ* spectroscopic techniques.

After identifying the most promising electro-organic processes, significant effort will be devoted to enhancing their robustness and reproducibility, thereby simplifying and streamlining their practical implementation and scale-up.