Organic Electrochemistry: Advancing the Science of Reactive Intermediates and Controlled Chemical Processes

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Because electrochemistry can be used to selectively create reactive intermediates and reverse the polarity of known functional groups, it has long held promise as a technique for both making and manipulating organic molecules. This promise led a group of very dedicated scientists to explore the utility of electroanalytic techniques for probing organic and organometallic reaction mechanisms, the effectiveness of electrochemistry for triggering unique and potentially powerful synthetic transformations, the power of electrodeposition approaches for building new surfaces and materials, and the efficiency of electrochemical methods for process synthesis and waste treatment. This pioneering work set the stage for truly capitalizing on what electrochemistry has to offer, an effort that continually results in the discovery and exploration of exciting new science.

At its core, organic electrochemistry is an extremely versatile tool for conducting electron transfer reactions, reversing the polarity of known functional groups and metal-based reagents, and triggering intriguing molecular transformations that allow for the development of entirely new synthetic pathways. In addition, the neutral reaction conditions and control of reaction potential afforded by electrochemical methods enable the study of electron transfer reactions involving a wide variety of substrates in a systematic manner. This leads to new mechanistic insights concerning the reactive intermediates generated that in turn lead to still more novel and intriguing transformations.

Efforts to develop electrochemical methods often capitalize on the novel technological aspects of the technique. From the use of reagentless, low temperature reaction conditions that enable the formation of intermediates for use in “flash-syntheses” or parallel micro-reactors, to chemically modified electrode surfaces that control the local environment of a reaction, to approaches for spatially isolating chemical reagents at preselected sites on a chip, to analytical developments for probing biological systems, to the use of novel electrodes and high throughput flow reactors for waste water treatment, electrochemistry offers many unique opportunities to achieve chemistry that simply can not be accomplished in any other manner. The result is a vibrant, growing area of research that will entice scientists for years to come.

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