

Amping Up Organic Synthesis with Electrochemistry

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Owing to its many distinct characteristics, electrochemistry represents an attractive approach to discovering new reactions and meeting the prevailing trends in organic synthesis. In particular, electrocatalysis—a process that integrates electrochemistry and small-molecule catalysis—has the potential to substantially improve the scope of synthetic electrochemistry and provide a wide range of useful transformations. Despite its attractive attributes and extensive applications in energy-related fields, electrocatalysis has been used only sparingly in synthetic organic chemistry. Thus, there exists a clear impetus for inventing new catalytic strategies to improve the scope of synthetic electrochemistry and provide new platforms for reaction discovery and synthetic innovations. Toward this end, we developed a new catalytic approach that combines electrochemistry and redox-metal catalysis for the functionalization of alkenes to access a diverse array of vicinally functionalized structures. This talk details our design principle underpinning the development of electrocatalytic alkene difunctionalization and hydrofunctionalization with a particular emphasis on enantioselective electrocatalysis. In addition, we harnessed the power of electrochemistry to discover a suite of radical silylation and alkylation reactions under strongly reducing potentials via the activation of chlorosilanes and alkyl halides. Finally, our recent forays into electrophotocatalysis will be discussed, in which we harness the power of both electricity and light to access catalytic species with exceptionally high oxidizing or reducing potentials.