

Catalytic enantioselective E1 eliminations

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Organic chemistry has a pivotal role in advancing the development of drugs, agrochemicals, and materials, all of which hold significant importance for society. These innovations depend on organic molecules, the synthesis of which is often the slowest and most resource-consuming step. Research in organic chemistry aims to streamline synthetic processes and reduce their environmental impact. In particular, catalysis holds great promise for shaping a sustainable future. Catalytic processes are environmentally significant because they often enable reactions to occur under mild conditions, reducing the energy input required for the process and minimizing waste. Notably, catalysis is employed in 90% of industrial-scale production, with an estimated 35% of the global GDP relying on this technology. Importantly, these numbers are expected to increase as we move towards more sustainable processes. Therefore, the development of new catalytic technologies is of paramount importance for society.

Chiral organic molecules, defined as molecules that cannot be superimposed on their mirror image, play a particularly crucial role in the development of new pharmaceuticals, agrochemicals, and materials. For example, two enantiomers (chiral molecules that are mirror images of each other) interacting with chiral enzymes in our body can elicit different responses. One enantiomer can be a desired drug, while the other can be ineffective or even harmful. Moreover, enantiomerically pure materials can feature unique properties. Therefore, chemists must synthesize these compounds with a precisely defined spatial arrangement. In this context, catalysis presents significant opportunities for synthesizing single enantiomers. The goal of this research is the development of catalytic enantioselective E1 elimination reactions. E1 elimination (unimolecular elimination) represents a fundamental transformation in organic chemistry, yielding olefins (compounds bearing a carbon-carbon double bond). Most olefins, however, lack chirality, which could be the reason why this technology was outside the scope of asymmetric catalysis for several decades. In this project, we have designed a series of catalytic enantioselective processes to unlock the potential of this technology for creating chiral molecules. It would enable a straightforward enantioselective synthesis of olefins bearing adjacent and remote stereochemical elements, as well as axially chiral olefins. The use of chiral organic catalysts will facilitate a sustainable synthesis of a broad range of compounds that holds promise for applications in medicinal chemistry and material science.