

Asymmetric hydroxylation of carbonyl compounds with photochemically generated singlet oxygen

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The goal of my studies was to develop an efficient and stereoselective method for hydroxylation of carbonyl compounds with photochemically generated singlet oxygen. The previously reported reaction conditions with *meso*-tetraphenylporphyrin as a photosensitizer and amino acids or silyl ethers of diarylprolinoles as an organocatalyst led to desired products with moderate yields and selectivities.

At the first stage of my work I conducted a detailed optimization of the reaction conditions with a broad screening of organocatalysts in the model hydroxylation of 3-phenylpropionaldehyde. I proved that the enantioselective hydroxylation can be performed in the presence of a wide range of secondary, cyclic amines. The (*R*)-enantiomer predominated in prolinamide-catalyzed reactions, while imidazolidinones assured the formation of the (*S*)-stereoisomer.

I prepared hybrid catalysts consisting of a porphyrin and L-proline moieties. The catalytic properties of the obtained porphyrins were examined in the model reaction. They all proved to generate the singlet oxygen nearly as efficient as *meso*-tetraphenylporphyrin but exhibited lack of stability thus little activity in the hydroxylation reaction.

Mechanistic studies including DFT calculations and detailed analysis of the reaction mixture, confirmed the enamine mechanism of the reaction. The key step involves the addition of singlet oxygen to an enamine leading to a zwitterionic intermediate. The intermediate can either hydrolyze to the desired product or form dioxetanes. I found that three crucial factors influencing the reaction course are: solvent polarity, temperature, and stable pH of the reaction mixture.

As the most important achievement, I consider the development of a method for hydroxylation of chiral β -substituted aldehydes. The reaction of enantiomerically pure 3,4-diphenylbutyraldehyde with singlet oxygen gave 3,4-diphenylbutan-1,2-diol with great diastereo- and enantioselectivity. The newly developed method for the synthesis of these compounds may increase their availability resulting in the discovery of interesting properties and applications.