

Description for the general public

Catalysis lies at the heart of synthetic chemistry. Needless to say, that majority of industrial processes rely on catalytic transformations, enabling efficient existence and development of modern societies. For instance, it is estimated that nowadays almost 80% of nitrogen atoms in human bodies originate from Haber–Bosch process (first commercialized in 1913), it being the basis of nitrogen fertilizers production. Similarly to large scale processes, catalysis is also most often crucial for fine chemical synthesis, in particular pharmaceuticals, crop protection chemicals, and their precursors. The possibility of performing multiple chemical transformations in an efficient and selective manner with all ingredients, reagents, catalysts, and intermediates present at the same time in one pot (as it happens in the Nature) is the Holy Grail of synthetic organic chemistry. The development of one-pot procedures and, even more profoundly, tandem reactions, brings scientists closer to this ultimate, but probably unreachable goal, by enabling the combination of several reactions into an operationally single process, thus avoiding laborious and expensive separation and purification of intermediate reactions products. The main objective of this project is to approach this ultimate, probably unreachable, goal by study and development of so called tandem reactions (also called cascade or telescope) catalyzed by compounds of a noble metal palladium. In this type of processes, several reactions, occurring at the same time in one pot, are combined in one process such as the product on one reaction is a starting material for the other. This challenging approach, conceptually similar to the assembly line in a factory, enables to avoid laborious and expensive separation and purification of products after each single step. However, providing compatibility of individual steps is demanding and requires good comprehension of reaction mechanisms.

The aim of this project is the development and deep studies of palladium-catalyzed tandem processes involving additions of enolates to alkynes followed by cross-coupling with aryl bromides. This approach, relaying on combination of two or more reactions, proceeding one after the other as a single process, enables rapid construction of complex, valuable molecules from simple, readily accessible building blocks. The development of the projected tandem methodologies would deliver new powerful tools for the efficient synthesis of a broad range of variously functionalized olefins. Deep understanding of the reaction mechanisms would provide a solid foundation for the extension of the developed methodologies and applications in various, even unforeseen, directions. The availability of a reliable and broadly applicable toolbox of synthetic procedures is expected to trigger broad-range research on the application of these classes of compounds in various branches of science in both academia and industry, including medicinal chemistry and smart material sciences.