DESCRIPTION FOR THE GENERAL PUBLIC

Why do chemists synthesize compounds? The answer is simple-people do need them. Organic compounds are present in a variety of products: from medicines to treat headache or child's fever, to the advanced materials that allow us to efficiently convert the solar energy into electricity. Unfortunately, most of the natural resources are limited, due to exploitation and geopolitical turmoil. We can no longer expect that they will be as available the day after tomorrow as they are today, thus we need to learn how to limit the use of energy and matter. This problem also affects chemistry, in the context of synthesis of molecules. Therefore, challenges such as atom economy, previously neglected, have become very important. For some time now, classical processes are being subsided by catalyzed transformations. Catalytic reactions require a small amount of the promoter. As a result, catalyst increases the reaction rate, sometimes permitting a reaction to be performed at all, while reduces formation of byproducts, and ultimately leads to a cleaner product.

An outstanding example of the dynamic changes occurring in the organic chemistry may be the evolution of Heck, Suzuki or Sonogashira reactions. The achievements of palladium-catalyzed cross-coupling reactions have recently been honored with the Nobel Prize in chemistry. Still they remain elegant and very efficient methods for creating new compounds. However, they require the use of specially prepared substrate. Moreover, traditional cross-coupling is characterized by poor atom economy. An alternative possibility was recently developed. It turns out that there are reactions, so-called C-H activation, in which the two C-H bonds can be coupled directly in the cross-dehydrogenative coupling process. This process alleviates the need for careful substrate modification, while requiring the presence abundant C-H bonds. Moreover, new methods appear, where expensive platinum metals are avoided.

The aim of the project is the design and synthesis of effective purely organic catalysts, which allow for selective preparation of the desired products applying C-H activation processes. We will try to significantly expand the scope of application of these processes, which are now limited to a small group of substrates, by using chiral hydrogen bond donors. Also, they will be applied in asymmetric catalysis applying non-classical techniques, such as hydrophobic amplification "on water" and the use of microwave irradiation. Moreover, we are going to limit the consumption of organic solvents by performing some reactions in a ball mill. We will learn how the catalyst systems behave in the reactions occurring in the solid phase. By anchoring the catalysts to the solid supports, we plan to improve their recyclability, and thereby make the process even more sustainable. We will also make efforts to develop the process where electromagnetic radiation (visible light) is applied to activate a simple substrate to form reactive intermediate, which will be further transformed into chiral products via hydrogen-bonding catalysis.

Some of the products obtained in the C-H activations, such as various tetrahydroquinolines can be found in plants and are of interest for pharma. Therefore, we believe that our research will provide scientific solutions for broad utility and meeting today's needs.