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**New approaches and tools for development of advanced functional materials**

Life is organic... Natural organics are all around us: wood, wool, cotton, food is organic. It seems that this is the reason why technology development through the centuries was bio-mimetic. Initially humanity used natural organics as construction materials, clothes, nutrition. The more advanced is the use of bio-inspired approaches in technology: synthetic polymers as analogs of natural fibers. Nowadays, we even came to a higher level of thinking of artificial life. It is claimed that artificial life can probably be even more efficient that the existing one.

Artificial organics are widely used and can be divided to different levels of complexity. The lowest level refers to polymers (polyethylene, polyamides and etc). These macromolecules are a sequence of repeated simple monomers. Next level of complexity corresponds to organic electronics. OLEDs consist of many layers of different complex molecules that can even contain metals. The most complex organic molecules are used in medicine. The complexity of such molecules is dictated by complexity of bio-molecules that they interact with. Thus it is no exaggeration to say: “If you want to make something innovative and real (something that you can touch, use or even swallow) most probably it will have a lot of organics in it”.

Nowadays no one needs molecules, but everybody needs good molecular properties. That is why the ultimate goal of modern organic chemistry is to reach the needed properties with the use of organic molecules. In general, the roadmap to make innovation using organics is:

* Understanding of the needed properties.
* Structure design.
* Synthesis.
* Application.

This logic is reflected in scientific approach of our group:

* Basic understanding of structure and bonding of organic and organometallic molecules.
* Experimental studies of reactive species.
* Knowledge based design and synthesis of catalysts, functional materials, green polymers.

Such an approach and broad expertise enables us to provide innovative solutions through multidisciplinary approach within one group. Our ultimate goal is to deliver scientific achievements to innovations. Our basic research lies in the following fields:

* Molecular simulation and modeling.
* Carbene chemistry, chemistry of transition metals.
* Catalytic synthesis of fine chemicals, polymers.

Our basic science is extended to applied research in collaboration with international chemical companies:

* Development of catalysts for PE and PP synthesis.
* Development of OLED materials.
* Development of catalysts for synthesis of biodegradable polymers.

In the lecture a modern view to ways of development of organic and organometallic chemistry will be presented. Fundamental studies of chemistry of stable carbenes and their transition metal complexes held in our group will be briefly reviewed. Case studies of development of new organic materials and tools to make new materials will be discussed.