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„*Synthesis and properties of zwitterionic rotaxanes and molecular switches*"

DESCRIPTION FOR THE GENERAL PUBLIC

In his famous lecture "There's Plenty of Room at the Bottom," an eminent physicist, R.P. Feynman, discusses nanomachines that manipulate single atoms and perform chemical syntheses. Back then the concept of molecular machines was only a vision. Today, however, chemists learn to construct and investigate molecular machines made up of a hundred atoms but yet able to perform mechanical motion on demand. Pioneering achievements in this area have been honored in 2016 with the Nobel Prize for J.F. Stoddart, J.-P. Sauvage and B.L. Feringa.

Molecular devices are present in nature—natural nanomachines are components of both eukaryotic and prokaryotic cells of living organisms. For example so-called motor proteins are powered by chemical energy derived from ATP molecules: Myosin is responsible for the work of our muscles, kinesins for transporting organelles in our cells, whereas dyneins drive the rotation of the cilia of moving bacteria. Synthetic molecular devices, which we still learn how to construct and investigate, are an attempt to imitate nature. As scientists we are keen to conduct research that is inspired by the living world.

The purpose of this project is to construct and investigate a specific type of molecular devices, called rotaxane molecular switches. These "circle on a stick" structures consist of a circular component that is permanently and inseparably threaded onto the axle. Such a molecule is a simple molecular device – on demand, and depending on the external signal, both components are moving in respect to each other, just like mechanical components of any machine do.

The project will start with the development of new methods of the construction of rotaxane molecular switches. Then, with the use of advanced analytical techniques, the properties and modes of action of a number of structures so obtained will be studied. What's more, unique structural elements will be used for the construction of switches – so-called macrocyclic metal complexes. Thanks to the use of metal ions, switches we are going to obtain will be much more resistant to continuous operation and consequently will show increased operational durability.

Choć nasze badania inspirowane są przyrodą, ich znaczenie nie zamyka się wyłącznie w walorze poznawczym. Syntetyczne maszyny molekularne znaleźć mogą w przyszłości zastosowania w fotonice, chemii materiałów, sensoryce, katalizie, a przede wszystkim w molekularnych układach elektronicznych (tego typu rozwiązania wykraczają poza fizyczne granice, przewidziane dla dobrze nam znanych, konwencjonalnych układów krzemowych).

There are practical applications to be foreseen for molecular switches: In the future, synthetic molecular machines might find applications in photonics, materials chemistry, sensors, catalysis and, above all, in molecular electronics, going beyond the physical boundaries limiting well known silicon systems.