New Directions in the Formation of Redox Active Polymers Constructed from Fullerenes and a Variety of Transition Metal Components

Continuous technological progress creates new challenges for science. One of them is the search for new materials that should be characterized by high durability, well-defined structure and properties. They must also be environmentally friendly. A desirable feature of such materials is also the possibility of their versatile technological application. Such properties are possessed by carbon materials, which are increasingly replacing traditional materials used in technology. Progress in the field of new carbon structures creating started with the discovery of fullerenes. Fullerenes exhibit resistance to high temperatures and pressure. Egzo- and endohedral doping of these materials allows to obtain fullerenes with the electrical properties of insulators, semiconductors, conductors and even superconductors. Their structure allows for various surface modification with organic, organometallic, and inorganic groups. Formation of fullerene derivatives with transition metals is a very important field in fullerene chemistry research. Such systems are used in devices converting solar energy into electricity and energy storage devices. They also show catalytic activity. These types of applications require knowledge of the electrochemical properties of fullerene derivatives, the mechanism and kinetics of the charge exchange and electron transfer processes. These issues will be the subject of this project. The research will cover both the already synthesized and described in literature complexes of fullerenes and transition metals, as well as new macromolecular systems synthesized within this project. In these new structures, electron-acceptor fullerene networks will be linked into polymer chains via organometallic electron-donor groups. Such a structure should ensure effective photon excitation, charge separation and electron transport through the polymer chain. In other synthesized systems, the fullerene networks will be linked into polymer chains via metal clusters. Such a structure should also ensure good electrical conductivity of the formed materials.

The second part of the project will be focused on the creation of transition metals with graphene quantum dots. Graphene quantum dots are carbon flat structures with dimensions not exceeding 10 nm. Their chemically reactive edges allow easy functionalization. Modified quantum dots dissolve in a number of solvents, which allows a number of chemical processes to be carried out on their surface. In this project, chromium will be linked to surface of graphene quantum dots via coordination bonds to form macromolecular complexes. Synthesis of macromolecular systems with the structure of coordination polymers is also planned. In this case, fullerene networks will be linked to the reactive edges to enable polymerization of the dots with transition metals.