The aim of this work is to design modern, alternative materials with catalytic properties based on nanocarbon supports and inorganic oxides carriers for model fine chemical production in flow reactor system.

The study will involve designing of new materials, characterization and demonstration of their catalytic potential in model chemical processes in flow reactor system, like: Diels-Alder cycloaddition and esterification of α-Angelica lactone to levulinic acid esters. Due to the importance of the products obtained according to the proposed processes, *e.g.* solvents, fuel additives, monomers, pharmaceuticals, efficient methods for their preparation are highly desirable.

The most important features of an effective catalyst is a high activity, selectivity and stability. The main advantage of heterogeneous catalysts, i.*e.* those which form a separate phase in the reaction system, usually solid is simple separation and recycle. Heterogeneous catalysis, although known for over a century, is constantly improved and plays a key role in solving the present problems in chemical technology. Thanks to the development of materials engineering modern, solid catalyst supports having a highly developed surface are available.

In the project new heterogeneous catalysts will be designed. Optimization of their mechanical, physicochemical and catalytic properties will be performed. Appropriate selection of the catalyst components - the active phase and the carrier - may affect its activity, selectivity and stability. It is also important to provide a good access of the reactants which create active phase by the expanding of the surface area. Another important issue is the mechanism of immobilization which is the method of depositing of the active phase on a support.

As the catalyst supports nanocarbon supports and inorganic oxide carriers will be used. Nanocarbon supports revolutionized the field of nanotechnology, finding use in electronics, optics, mechatronics and as structural components. Specific properties of nanocarbon supports, such as high surface area, chemical inertia, the relatively high resistance to oxidation, the ability to make various modifications on the surface make them promising carriers for heterogeneous catalysts. Inorganic oxide carriers SiO_2, Al_2O_3 or their mixtures ZrO_2-SiO_2 or Al_2O_3-SiO_2 are cheap materials in production, they are characterized by high porosity and developed specific surface and additionally characterized by high mechanical resistance.

Carriers will be modified by depositing on their surface of active groups with catalytic capability in the form of carbohydrates based ionic liquids (ILs) or acidic ILs and also enzymes. The deposition will be carried out by adsorption of the active phase or by chemical bond to the carrier. The latter approach is more efficient and prevents leaching of the active phase during the process, separation and recycle of the catalyst. The combination of high catalytic potential of ionic liquids and enzymes with excellent carrier properties leads to a hybrid materials with innovative properties.

For the preparation of heterogeneous catalysts we will use nanocarbon supports, i.e. pristine and surface-modified single- and multi-wall carbon nanotubes, whereas, as inorganic oxide composites will be used, i.e. ZrO_2-SiO_2 or Al_2O_3-SiO_2, and comparatively SiO_2, Al_2O_3, ZrO_2.

It is worth noting that the use of hybrid materials (SILP) as catalysts in flow reactor system in liquid phase previously has been described in few works and they lack a comparison of the impact of the support type structure on the ability to modify and stability of the catalyst.

The studies under the favourable conditions, e.g. temperature, concentration of reagents, the amount of catalyst, and solvent selection will be realised. In addition, in the research the type of support and its morphology will be analysed for the active phase immobilization and catalyst stability.

In conclusion, the search for new highly effective, yet non-toxic, environmentally friendly catalysts are currently the object of many studies. The proposed project involves the use of new, yet poorly known heterogeneous catalysts based on hybrid materials constructed from a combination of nanocarbon supports or inorganic oxide composites and ionic liquids or enzymes for model chemical processes.