

## DESCRIPTION FOR THE GENERAL PUBLIC

The need for environmental protection and continuous depletion of fossil raw materials have stimulated intense search for renewable resources for the production of many valuable chemicals and for design of processes which would prevent waste generation. In response to the above needs, the scientific interest has been shifted towards carbohydrates as feedstock for fine chemistry. This project is concerned with the design and construction of heterogeneous catalysts that would be successful in the production of gluconic acid from glucose, acrylic acid from glycerol and maleic anhydride from bioethanol. The choice of carboxylic acids which are planned to be formed over the new catalysts is dictated on the one hand by their importance (e.g. D-gluconic acid (100 000 tons per year) is widely used in the food, pharmaceutical, paper and concrete industries; acrylic acid is mainly used in the manufacture of polymers to produce e.g. paint, adhesives, plastic, rubbers; maleic anhydride is used in nearly every field of industrial chemistry especially in the production of polymers); while on the other hand by the renewable resources from which they can be catalytically obtained (glucose - obtained from starch or by hydrolysis of cellulose; glycerol - byproduct in the production of biodiesel, bioethanol - formed in biochemical conversion of lignocellulosic feedstocks to ethanol). Moreover, our aim is to use heterogeneous catalysts (not homogeneous ones) which can work in both liquid and gas phases and for reactions performed without the use of alkali solutions (sources of waste). Generally, the replacement of homogeneous catalysts by heterogeneous ones offers such advantages as simplification of the process, cost reduction by minimizing the number of operations needed and easier adaptation to continuous processes in fixed-bed reactors. Another important advantage is the fast and easy separation of a heterogeneous catalyst from the reaction mixture without the use of neutralizing agent. Therefore, much effort has been directed to design heterogeneous catalysts able to catalyze the tandem reactions, which besides are eco-friendly and could be as effective as homogeneous ones and would be able to replace the homogeneous systems. All these issues, i.e. the use of renewable resources for the production of valuable carboxylic acids, and design of heterogeneous catalysts able to replace homogeneous ones as well as work in the multistep tandem reactions mean that the submitted Project fits the global trend research taking into account the environmental protection.

The aim of the project is to synthesize, comprehensively characterize and test the performance of new heterogeneous catalysts based on ordered mesoporous materials of SBA-15 type, mesoporous cellular foams MCF, mesoporous mixed metal oxides and layered MWW zeolites, in which the redox centers will be generated by modification with gold, copper, vanadium and niobium, basic oxygen will originate from calcium or cerium species and weak/medium acidic centers will be obtained by anchoring organosilanes containing COOH, PO<sub>3</sub>H or SH groups. The idea is to obtain the heterogeneous catalysts effective in the two groups of reactions: i) oxidation of aldehyde to carboxylic acid (glucose to gluconic acid) and ii) oxidehydration of alcohols (glycerol to acrylic acid, bioethanol to maleic anhydride). The idea is to obtain the heterogeneous catalysts effective and stable in the production of acids and anhydride mentioned above, as well as to get insight into the pathways of the reactions over these catalysts. Of particular concern is design of multifunctional catalysts addressed to oxidehydration of glycerol and ethanol.

The choice of mesoporous supports for the catalysts planned to be obtained for oxidehydration processes was dictated by ability of easier mass transport of reactants and products, in this way promoting the catalytic activity and protecting against coke agglomeration in the pores. Moreover, such supports should secure appropriate distance between acidic and oxidizing centers, necessary for this tandem reaction. Thus, the focus of the Project is on the use of opened micro- mesopore structure of MWW zeolites MCM-36 type (formed by pillaring of MCM-22). Their acidity will originate not only from zeolitic bridged hydroxyls but also from anchored organosilanes containing COOH or PO<sub>3</sub>H or SH groups. Oxidative activity will be enhanced by additional (besides vanadium) modifiers like niobium, copper and gold. Similar multicomponent active phases will be supported on mesoporous silicas of SBA-15 and MCF types. The proposed systems have not been studied yet in the context of glycerol oxidehydration or transformation of ethanol to maleic anhydride. They seem to be very promising because of the properties of planned components which meet the conditions required for good catalysts of this process.