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Fields of research

- Advanced catalytic oxidation processes
- Catalytic combustion of volatile organic compounds in waste gases
- Catalytic decomposition of N_2O
- Design of new theoretical models for structure-activity relationships
- Morphology and application properties of catalysts based on functional polymers
- Preparation of hierarchic nanomaterials
- Temperature programmed techniques in characterization of catalysts
- Texture and transport processes in porous solids
- Theoretical analysis of the structure of molecules with complicated bonding pattern
- Preparation and characterization of the electrospun nanofibrous membranes and catalytic supports
- Unconventional preparation of metal oxide nanostructures by pressurized fluid extraction and supercritical drying

Applied research

- Catalytic combustion of volatile organic compounds
- Oxidation processes for environment
- Textural characteristics of structural materials
- Green chemistry for biomass utilization to the high added-value products

Research projects

Hydrogen oriented underground coal gasification (UCG) for Europe - environmental and safety aspects (HUGE2)

(O. Šolcová, solcova@icpf.cas.cz; joint project with GIG, Politechnika Slaska, Kompania Węglowa S.A. and Lubelski Węgiel Bogdanka S.A., Poland, Institut National de l`environnement industriel et de risques, France and UCG Engineering Ltd, UK; supported by Research Fund for Coal and Steel (RFCS), project No. RFCR-CT-2011-00002)

This project is focused on safety and environmental aspects of underground coal gasification. Underground trial has been performed in mine testing two borehole system and reactive barriers usage. The most serious environmental concerns related to UCG have been investigated that is contamination of underground aquifers and potential leakage of poisonous and explosive gates into the surrounding strata. The work is focused on finding practical solutions of possible leakages prevention by use of reactive barriers. Complex system of environmental telemetric monitoring was built and tested. Also technical and ecological risk assessment was performed.

During the UCG process as well as a long time after the process termination a great number of hazardous environmental contaminants (both inorganic and organic species) can be released into the groundwater environment. Within this project, the solute transport processes in groundwater were modeled using the saturated zone model of groundwater flow including phenomena that incorporates advection, both mechanical and hydrodynamic dispersion, solute diffusion as well as adsorption of solutes on the rock inner surfaces. Used model was formulated under consideration of the rock saturation with water. Water fills completely all volume of voids in porous rocks and creates a saturation zone. From a mathematical point of view, the model description takes into consideration Darcy's law, Fick's law of diffusion and equation of adsorption isotherms.

Fly ash from coal combustion have been chosen as potentially best fill material for filling of UCG voids and control of release and migration of contaminants due their widely known ability to isolate contaminants, between other in landfilling, beneficial physical properties and availability. From the point of the view of isolation of contaminants a very important factor is the filtration coefficient of solidified (stabilized) fly ash – water mixtures, what become subject of laboratory measurements. [Ref. 26]

Pilot reactor with reactive barrier made by active carbon after 5 days processing

Removal of heavy metals and radionuclides from water using ceramic membranes

(O. Šolcová, solcova@icpf.cas.cz; joint project with Institute for Single Crystals of NAS of Ukraine and University of Maribor, Slovenia; supported by NATO, project No. SFP 984398)

The problem of environmental pollution with radionuclides is especially acute in Ukraine after the Chernobyl catastrophe in 1986 which caused serious radioactive contamination of the surface aquatic environment. Even currently uranium concentration in liquid low-level radioactive wastes from the object "Shelter" in Chernobyl Exclusion Zone exceeds 30-40 mg/l. These wastes require treatment to meet discharge regulations to the inland waterways and to minimize the volume of radioactive material to be stored. Additionally, Ukraine ranks sixth place in the world and first in Europe regarding the reserves of uranium ores. Large volumes of drainage and process water contaminated with uranium and other radionuclides are formed during mining and enriching of uranium ores. Unfortunately, this polluted water as a rule enters the environment without adequate treatment.

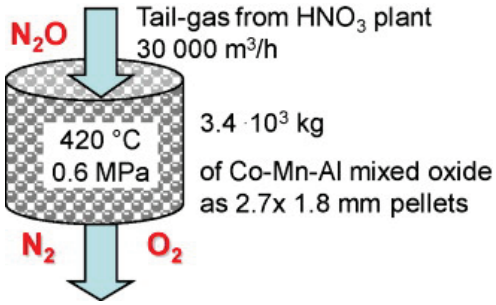
Therefore, the main objective of the project is to develop a family of advanced nano- and ultrafiltration ceramic composite membranes containing functionalized mesoporous silica layers which will be capable of selective binding of heavy metals (Hg, Cd, Cr) and uranium from surface and waste waters and thus preventing or minimizing the environmental exposure to hazardous substances. [Ref. 24]

Abatement of N_2O emissions in off-gas from nitric acid technology

(K. Jirátová, jiratova@icpf.cas.cz; joint project with TU of Ostrava, and ICT; supported by TACR, project No. TA01020336)

Alkali promoted Co_4MnAlO_x mixed oxide (molar ratio of alkali metal/Co = 0.037) were prepared by impregnation of calcined Co-Mn-Al hydrotalcite (molar ratio Co : Mn : Al = 4:1:1) with an aqueous solution of Li, Na, K, Rb or Cs nitrate. N_2O conversion over alkali promoted Co_4MnAlO_x mixed oxide decreased in order Cs > Rb > K > Na = Co_4MnAlO_x > Li in inert gas and was shifted to the lower values in the presence of typical components (NO_x, O_2 and H_2O) of flue gas. The addition of alkali promoters to the Co_4MnAlO_x mixed oxide resulted in a modification of both electronic properties of active metals and acid-base function of the catalyst surface. The promotional effect of alkali metals is connected with their ionization potential, the charge transfer to the catalyst and a decrease in binding energies of all catalyst components (Co, Mn, Al and O). Pilot plant verification of N_2O decomposition over K-promoted Co_4MnAlO_x is shown.

A catalyst for N_2O removal from effluents of nitric acid plants was patented. The catalyst consists of calcined beta-cobalt hydroxide and Cs. The catalyst is prepared by action of NaOH on cobalt nitrates solution in molar NaOH / $Co(NO_3)_2$ = 0.5 to 2.0 at 20 to 25 °C under mixing for 5-10 min, then is dried, formed into pellets, calcined and impregnated with water solution of Cs compounds to meet molar ratio Cs to Co_3O_4 in the range from 0.003 to 0.060 and again is calcined. Concentration of N_2O in the treated gas is lower than 150 ppm, when initial concentration of N_2O is 1000 ppm and GHSV 0.001 g min ml^{-1}. [Refs.19, 31]

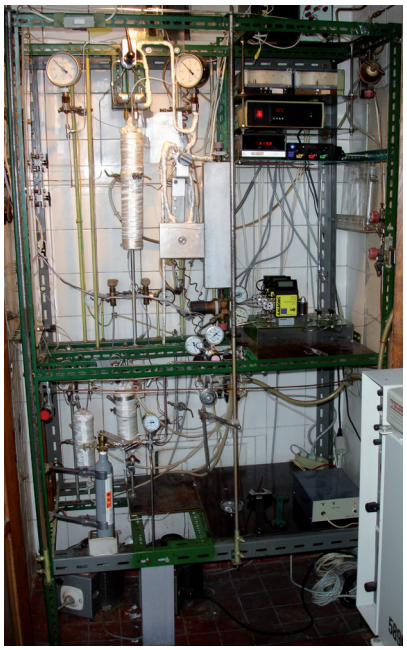


Scheme of the reactor arrangement for N_2O decomposition

Study of hydrodesulfurization and its inhibition by hydrogenation (denitrogenation) over catalysts containing small amounts of noble metals

(Z. Vít, vit@icpf.cas.cz; joint project with Department of Chemistry, Physics and Environment, University of Udine, Italy; supported by GACR, project No. 104/09/0751)

Acidic supports and active phases containing noble metals were studied for hydrodesulfurization (HDS) of model compounds such as thiophene and benzothiophene. Silica-alumina's modified by post-synthesis acid extraction were studied as possible supports of bimetallic Pd-Pt catalysts. The extraction of support increased the surface areas and exposed more Brønsted acidic sites which improved the HDS activity of catalysts. HDS activity was greatly affected by metal precursor and the way of catalyst pretreatment. It was shown that a fraction of active phase, enriched by Pd, accumulated hydrogen in the form of β-Pd hydride phase. Amounts of hydrogen held by hydride phase correlated with thiophene HDS activities showing that activated hydrogen participated in HDS. The inhibition effects of pyridine and quinoline on HDS of thiophene and benzothiophene were studied on Mo and Pd-Mo/alumina catalysts. Noble metal containing catalysts were generally less sensitive to nitrogen bases than conventional CoMo catalysts. Activities and nitrogen tolerance were in relation to C-N bond breaking activity of nitrogen inhibitor.



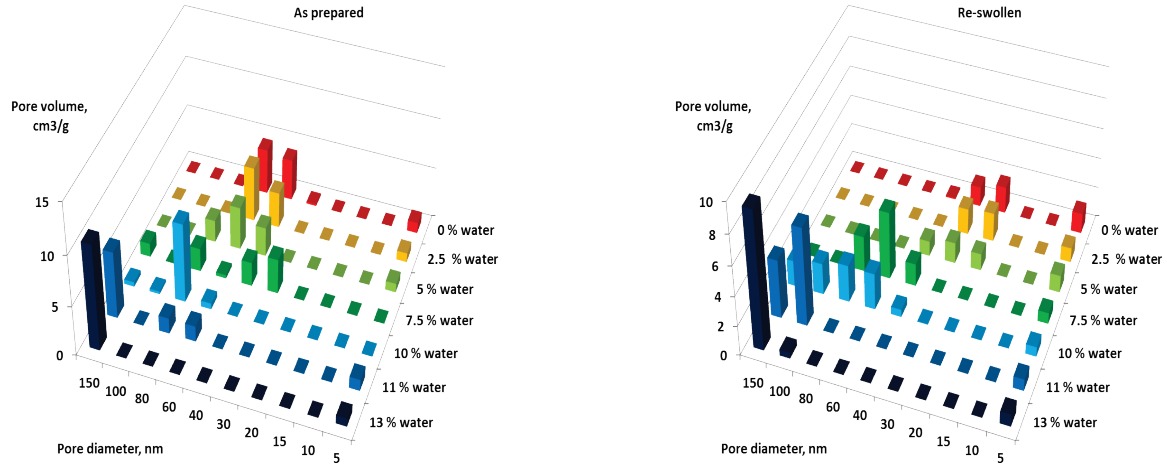
Pressure flow microreactor with fixed bed of catalyst for hydrodesulfurization

Morphology and application properties of mesoporous poly(divinylbenzenes)

(K. Jeřábek, kjer@icpf.cas.cz; joint project with Zhejiang University, Hangzhou, China; supported by MEYS, project No. LH12194)

Chinese colleagues discovered a novel polymerization method producing porous polymers with very high surface area and unique mesoporous morphology, completely different from conventionally prepared materials of similar chemical nature. In their preparation is used exceptionally high dilution of monomers with porogenic solvents. With help of inverse steric exclusion chromatography method developed in Prague providing information on the polymer morphology in its native, swollen state undeformed are investigated relations between preparation conditions of mesoporous functional polymers and their morphology and applications for which the exceptional properties of the mesoporous functional polymers could be advantageous. It was found that the pore volume in the polymer examined just after preparation corresponded to the volume of the porogen used. Resulting high porosity exceeding 90 % can be explained only on the basis of pore formation through

microsyneresis rather than the macrosyneresis mechanism that is common in the synthesis of conventional porous polymer materials. Drying of the polymers of course induces extensive collapse of the porous structure. Water, as additive to the porogenic solvent, influences ability of the polymer morphology to re-swell to its original state.

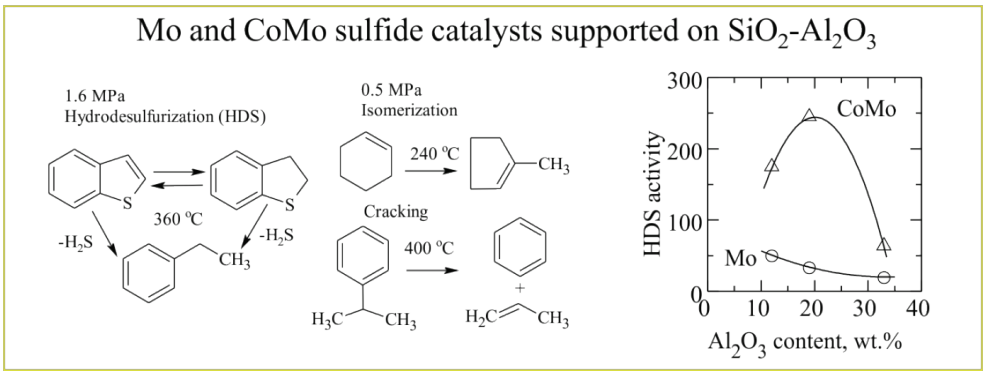


Influence of addition of water to porogenic solvent on the swollen-state morphology of mesoporous poly(divinylbenzenes

Unconventional composition and preparation of sulfide hydrotreating catalysts

(L. Kaluža, kaluza@icpf.cas.cz; supported by GACR, project No. 106/11/0902)

Catalysts with various MoO_3 and Al_2O_3 contents were prepared by a reaction of acidic SiO_2-Al_2O_3 supports with aqueous slurry of MoO_3. The saturated adsorption amount of MoO_3 corresponded with the amount of Al_2O_3 in the supports. The deposited and sulfided Mo species were accessible for promotion of the activity and selectivity in benzothiophene hydrodesulfurization reaction by Co. The acidity of the SiO_2-Al_2O_3 supports modified by dealumination by leaching with nitric acid in terms of cyclohexene isomerization and cumene cracking were preserved after deposition of the CoMo sulfide phase. Furthermore, a new method based on impregnation of unconventional supports (i.e. activated carbon and ZrO_2) by the nitrilotriacetic acid (NTA) assisted spreading of molybdenum trioxide with cobalt carbonate, or ammonium heptamolybdate with cobalt carbonate was investigated. The NTA systematically increased the promotion effect of Co in the sulfided catalysts in comparison to samples prepared without NTA from ammonium heptamolybdate and cobalt nitrate. The promotion effect of Co was expressed as ratio of activity of CoMo catalyst and its Mo counterpart and NTA increased it by the factor 1.13-1.58 for the studied supports. [Refs. 8, 9]



Model hydrotreaning reactions for unconventional catalysts

Microalgaes as a promising sources of omega-3 unsaturated fatty acids and their incorporation into the human food chain

(F. Kaštánek, kastanek@icpf.cas.cz; joint project with Rabbit Trhový Štěpánov a.s., IBOT, EcoFuel Laboratories, Institute of Microbiology ASCR, Mydlářka a.s., Rabbit CZ a.s., Rabbit Chotýšany a.s., CU, ICPF, ICT Prague; supported by TACR, project No. TA03011027)

The project is focused on utilization of the lipid new sources with the high content of the healthy polyunsaturated fatty acids (PUFAs), omega-3 types. Microorganisms, mainly biotechnologically produced eustigmatofit microalgaes with the high content of PUFA, have been applied. New types of mixotrophic bioreactors were designed to obtain the optimal content PUFA in biomass. Products will be used as the feeding additives for poultry.

The newly designed biophotoreactor

Innovative autoMotive MEA Development - implementation of Iphe-genie Achievements Targeted at Excellence (IMMEDIATE)

(L. Kaluža, kaluza@icpf.cas.cz; supported by European Union´s 7th Framework Programme FP7/2007-2013 for the Fuel Cells and Hydrogen Joint Undertaking Technology Initiative, project No. 303466 and co-supported by MEYS, project No. 7HX13003)

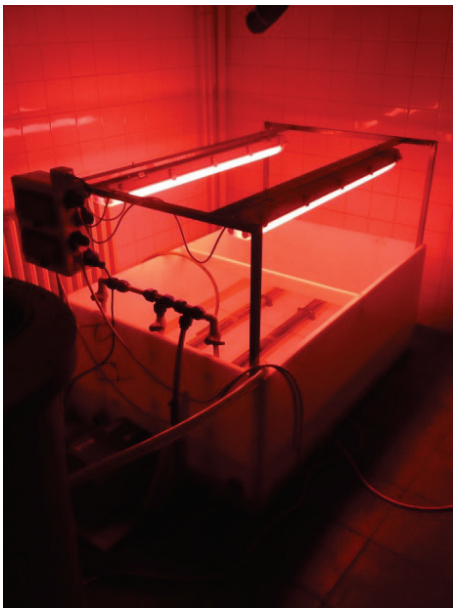
Fulfilling of increasingly stringent environmental restrictions imposed on transportation drives the research on alternative energy resources such as hydrogen and fuel cells. Preparation of carbon black supported 60 wt. % Pt was studied as a conventional catalyst for membrane electrode assembly. Platinum was deposited on the supports XC72R, XC72 (Vulcan, Cabot Corp.), and ENSACO 290G, 350G (Timcal Graphite & Carbon Ltd.) and a research grade PT-P (Timcal Graphite & Carbon Ltd.): (i) from true solutions of H_2PtCl_6, $Pt(C_5H_7O_2)_2$, $Pt(NH_3)_4(NO_3)_2$, or $Pt(NH_3)_2(NO_2)_2$, and (ii) from fine dispersions of $Pt(C_5H_7O_2)_2$, PtO_2, $Pt(NH_3)_4(OH)_2$. Atomic adsorption spectroscopy and scanning electron microscopy were used for elemental analysis and determination of Pt content. N_2 adsorption-desorption measurements revealed highly developed mesoporous system with maximum on the pore-size distribution curve at pore-size radius 7 nm for Pt-P, which was quite unique among the studied supports. Deposited Pt species were dried, calcined or reduced and were subjected to temperature programmed reduction (TPR). After degassing at increased tempera-

ture, the Pt dispersion was determined by hydrogen chemisorption at - 60 °C. TPR revealed that PtO_2, H_2PtCl_6, $Pt(C_5H_7O_2)_2$, $Pt(NH_3)_4(NO_3)_2$, and $Pt(NH_3)_2(NO_2)_2$ deposited on carbon blacks and dried in rotary vacuum evaporator at 95 °C were reduced to metallic Pt at 0, 70, 120, 140, 150 °C, respectively. Specific interaction of the Pt precursor with support surface was considered necessary for formation of the desired 4-6 nm Pt particles from H_2PtCl_6 or $Pt(NH_3)_2(NO_2)_2$. The deposition of colloidal form of PtO_2 or $Pt(C_5H_7O_2)_2$ seemed to be particularly promising because it represented relatively clean and gentle method of Pt deposition. This was manifested by the sharp reduction peaks but the tailored high Pt dispersion was not reached.

Reactive chemical barriers for decontamination of heavily polluted waters

(P. Klusoň, kluson@icpf.cas.cz; joint project with Dekonta a.s.; supported by MIT, project No. FR-TI1/065)

The project was focusing on the final studies of the special oxidations of contaminants in industrially polluted waters. Special attention was paid to aniline and nitrobenzene waters, to waters with dissolved chlorinated compounds and to inorganic contamination with certain specific ions. The used methods were the photocatalytic oxidations with phthalocyanines, name with Zn phthalocyanine, and with UVC and hydrogen peroxide. Among other techniques electrocoagulation was also tested to reduce both the organic as well as the inorganic pollutants. The project thus deals in a complex manner with the problem of industrial pollution of various types and origins. The Recheba concept represents a kind of passive approach, however, assisted with highly advanced processes for effective water decontamination. The systems had been still tested on a laboratory scale, however, much more attention was now paid to the large scale operations. [Ref. 30]



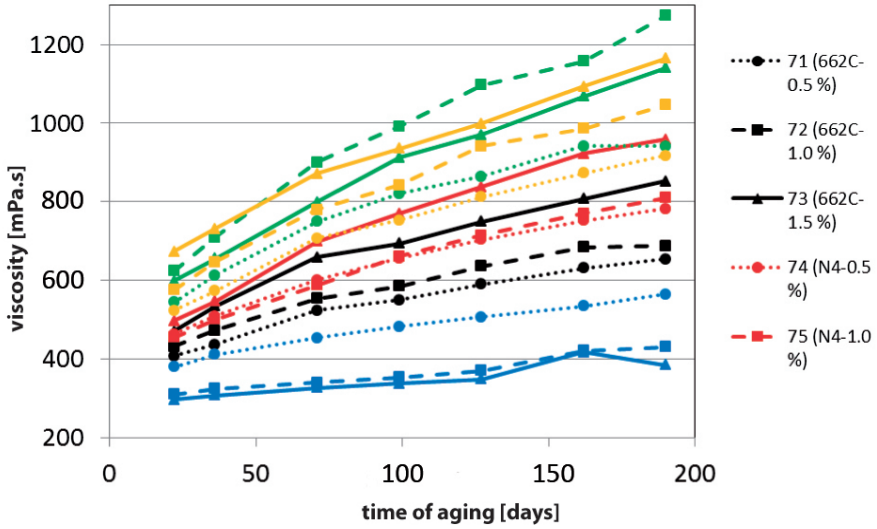
Detail of the phthalocyanine decontamination unit

Research and development of special dyes using ionic liquids as efficient functional additives

(P. Klusoň, kluson@icpf.cas.cz; joint project with Teluria, Techem; supported by MIT, project No. FR-TI3/057)

This project deals with utilization of special types of ionic liquids based on tetra-alkylammonium bistriflateamides as additives for new types of dyes. These additives may

bring special properties to the final product, such as higher mechanical stability, higher effect of the pigment addition and lower amounts of various pigments, more complex compositional solutions, etc. The project comprises preparation of the selected ionic liquids, their characterization by many types of physical methods (viscosity, contact angle, density, etc.), and then their direct application together with other characteristic components. The project addresses completely new way to obtain modern dyes useful both in industry as well as for standard and common customers.



Viscosity change (at T = 23°C) in time of alkyde resin with various ionic liquids at three concentrations (additives do not change the Newtonian character of resin)

Research and development of advanced thin film elements for direct evaluation of the time variable with by means of the preciously calibrated color change

(P. Klusoň, kluson@icpf.cas.cz; joint project with INVOS Ltd., COC Ltd., CU, ICPF, TU Brno; supported by TACR, project No. TA03010548)

Aim of the project, shortly named *Color Clocks,* focuses on the applied research & development and testing of the advanced thin film elements for direct evaluation of the time variable by means of preciously calibrated color change. These elements represent a highly specific form for time measurement under highly specific conditions and for very specific practical purposes. These structures are supposed to be used as tools for simple visual and intuitive evaluation of the time variable under very different circumstances. It is a kind of standard memory element collecting a certain type of data, which are then assessed in the cumulative form as the absorbed light dose of characteristic energy, or characteristic energetic region. The light sensitive films are based on uniformly organized nanoparticles that exhibit an adjustable photocatalytic activity toward the decomposition of selected organic structures deposited onto their surfaces. The decolorization process is then carefully calibrated for many different types of probe organic molecules. There are many possible practical applications of these materials, among others dermatology, conservation and storage of historical monuments and artefacts, should be mentioned.

Use of PFG NMR, stochastic reconstruction and molecular simulation to estimate transport-related texture characteristics of advanced porous materials

(O. Šolcová, solcova@icpf.cas.cz; joint project with CU and JH IPC; supported by GACR, project No. P204/11/1206)

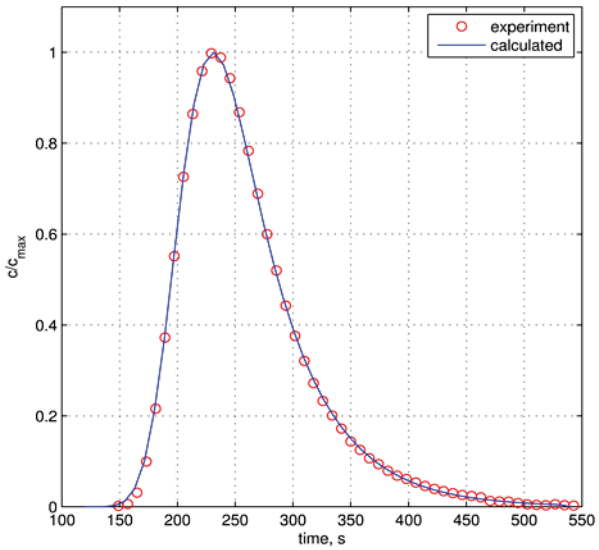
Searching after the functional relationship between diffusion of fluid in disordered solids (e.g. porous solids) and their microstructure is an active field of research in membrane scien-

ce, catalysis, biophysics, civil engineering and other branches of research and development. During several past decades the pulsed field gradient (PFG) NMR technique has proved to be a powerful tool for measuring of self-diffusion in such systems. The focus of the project is on transport investigation of liquid species contained in porous materials (non-consolidated and consolidated) with monodisperse and bidisperse porous structure with excursions to adjacent supercritical regions. A rational system of transport-related structure characteristics to predict transport behavior of liquids and supercritical fluids will be searched by combined application of PFG NMR, image analysis of porous materials and molecular simulation of self-diffusion in selected two-phase systems.

The effective transport properties of advanced porous materials based on hydroxyapatite nanopowders were characterized by means of the effective diffusion coefficients. Polystyrene molecules substituted a role of biofluids transported in human body (especially in bones) were used as appropriate model compounds.

The effective diffusion coefficients for two polystyrene samples with different relative molecular weights (1000 and 100,000) in cyclohexane on hydroxyapatite were evaluated Comparison of the chromatographic response signals for polystyrene tracers with different molecular weights is depicted in Fig. Furthermore, Fig. illustrates a very good fit between experimental data (circle marks) and the calculated chromatographic response signals (solid lines) based on the optimized model parameters.

It was found that the binary effective diffusion coefficients revealed much lower values in comparison with the binary bulk ones due to the strong influence of hindered diffusion in hydroxyapatite pore network. [Refs. 25, 29].



Response curve for polystyrene (M_w = 100,000) in cyclohexane on hydroxyapatite. Experimental (°), calculated (—)

Removal of endocrine disruptors from waste and drinking water by photocatalytic and biological processes

(O. Šolcová, solcova@icpf.cas.cz; joint project with Dekonta, a.s. and Institute of Microbiology ASCR; supported by TACR, project No. TA01020804)

Endocrine disruptors represent the group of chemical substances disrupting the hormonal indication of vertebrates and thereby they could encroach on the organism function. To the group of endocrine disruptors belong surfactants, softeners, fungicides, insecticides and some kinds of medications and hormonal contraception. They are commonly presented not only in

the waste water but also in the natural water. Endocrine disruptors are persistent to degradation by common chemicals as well as biological and photolytic processes. The necessity of finding the alternative solutions leads to development and use of the new technologies. Photo-catalysis using semiconductor particles have found increasing interest to solve the endocrine disruptors remove problems.

This study is focused on verification of the specially designed photoactive materials and their modified versions suitable for photo-processes carried out upon illumination in the UV-light. Ethynylestradiol, nonylphenol and bisphenol A were chosen as typical compounds belong to the endocrine disruptor group. In this work the water decontamination with various concentrations of endocrine disruptors in the two types of reactors; batch and plug flow arrangement on the titania thin layers were studied. Moreover, the application of the specially designed pilot plan photoreactor has been studied. [Ref. 16]

Pilot plant photo-reactor

Ionic liquids as additives for special pigments

(O. Šolcová, solcova@icpf.cas.cz; joint project with Synthesia, Techem; supported by MIT, project No. FR-TI4/189)

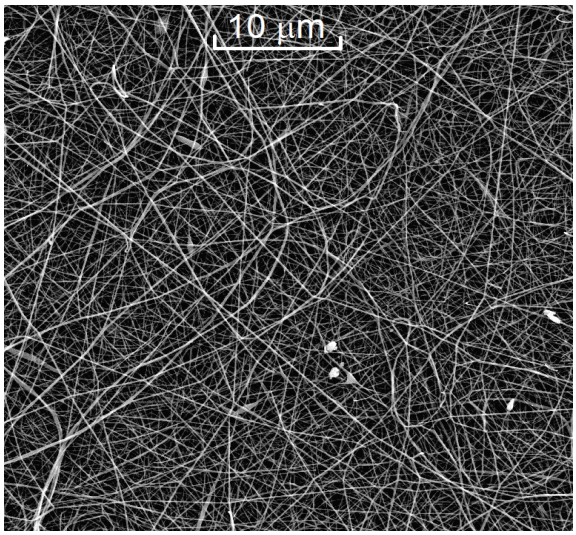
Ionic liquids are composed of large ions with a low degree of the overall molecular symmetry. Very high coloumbic interactions are behind their impressive electrical and mechanical stabilities, thermal and pressure resistivity, and extremely low tension of vapors. Low flammability, very good electrical conductivity, high thermal capacity and unusual phase behavior might be added to the previous list of exceptional properties. No doubts these features qualify them for a broad band applications ranging from “green solvents” due to their negligible volatility, over templates for synthesis of nanoparticles (some of them tend to form organized ionic clusters), liquid electrolytes in solar cells and fuel cells, to liquid adhesives, special lubricants, chromatography mobile phases, incombustion additives, etc.

One of the most prominent applications is their use as special additives for pigments and dye compositions. If the side-chains are too short, they do not disturb the ionic network significantly and, also, they do not possess enough conformational freedom to adopt a low energy configuration. However, increasing the chain-length the role of its spatial arrangement becomes much more important. In this respect this project pays special attention to the utilization of quartenary ammonium ionic liquids, namely n-alkyl-triethylammonium bis(trifluoromethane sulfonyl) imides ($N_{R222}Tf_2N$, R = 6, 7, 8, 10, 12, 14) with a variable length of an alkyl chain are specially promising.

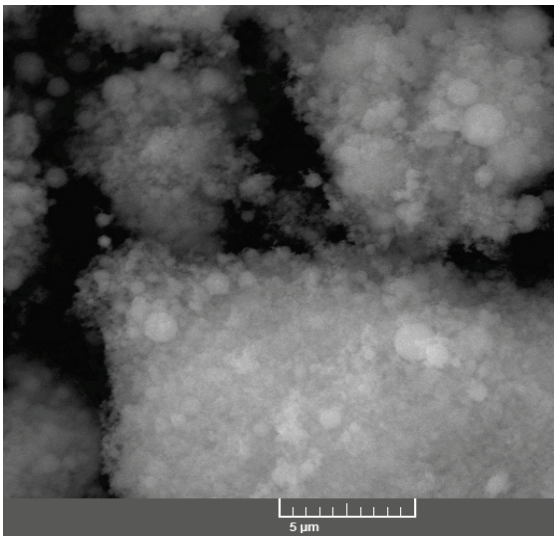
Transport characteristics of novel biocompatible materials

(K. Soukup, soukup@icpf.cas.cz; supported by GACR, project No. P106/11/P459)

The aim of the project was focused on comprehensive characterization of the microstructure properties of the novel biocompatible porous solids included both electrospun polymeric membranes and bone-like hydroxyapatites. In order to prepare materials having the targeted effects for the required applications (both in medical and chemical), the knowledge of the transport characteristics typical of its pore network is of the prime importance. Four experimental setups were utilized for the transport characteristics determination: Graham's diffusion cell, Wicke-Kallenbach cell, and permeation cell were used for the gas transport measurements and inverse liquid chromatography technique for diffusion measurements in liquids. Special attention was paid to the detailed statistical analysis of the optimized transport parameters and effective binary diffusion coefficients. The statistical reliability of the calculated transport parameters was assessed by means of their confidence regions (from diffusion measurements) and confidence intervals (from permeation measurements) computed at a significance level of 5%. It was found that the confidence of the optimized transport parameter ψ (from diffusion) and $\langle r \rangle \psi$ (from permeation) reflecting the influence of the molecular and Knudsen mass transport mechanism, respectively, was much higher than transport parameters $\langle r \rangle \psi$ (from diffusion) and $\langle r^2 \rangle \psi$ (from permeation). It was additionally found that tracer solute with the larger molecular weight shows shorter retention time compared to tracer solute with the lower molecular weight. The observed difference in retention times corresponds to expectation that the short-chain solute will penetrate deeper to the pore system of biocompatible nanopowders and will be more retained in comparison with the long-chain solute. [Refs. 25, 26, 29]



Micrograph of nanofibrous chitosan



Micrograph of bone-like hydroxyapatite

New heterogeneous catalysts for environmental protection

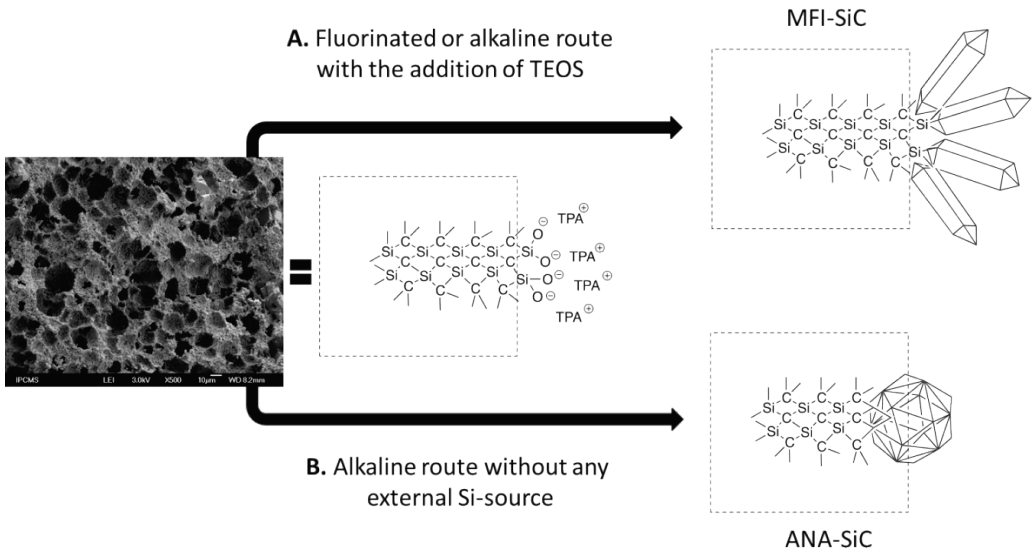
(L. Kaluža, kaluza@icpf.cas.cz; joint bilateral co-operation with Institute of Catalysis, BAS, Sofia, Bulgaria; supported by ASCR)

High surface area TiO_2 nanotubes (Ti-NT) synthesized by alkali hydrothermal method were used as a support for NiW hydrodesulphurization catalyst. Nickel salt of 12-tungstophosphoric acid ($Ni_{3/2}PW_{12}O_{40}$) was applied as oxide precursor of the active components. A polytungstate phase evidenced by Raman spectroscopy was observed indicating the destruction of the initial heteropolyanion. The catalytic experiments revealed two times higher thiophene conversion on NiW catalyst supported on Ti-NT than those of catalysts supported on alumina and titania. Increased HDS activity of the NiW catalyst supported on Ti-NT could be related to a higher amount of W oxysulfide entities interacting with Ni sulfide particles as consequence of the electronic effects of the Ti-NT observed with XPS analysis. [Ref. 20]

Novel materials with hierarchical pore structure: preparation and evaluation of the transport characteristics

(K. Soukup, soukup@icpf.cas.cz; joint bilateral project with University of Strasbourg;
supported by MEYS, project No. 7AMB12FR029)

In the present bilateral project, we would like to propose strategies towards the design of structured catalytic beds made of hierarchical zeolites with improved hydrodynamics (compared to extrudates or conventional pellets), combining both the advantages of zeolitic catalysts and of a tailored porosity (triple level of porosity: micro-, meso- together with an appropriate macroporosity). Several syntheses have been performed to allow the growth of zeolite crystals on α-silicon carbide supports (α-SiC). Silicon-carbide foams exhibit a duplex macroporous structure. Framework type MFI and ANA of zeolites have been successfully coated to this relatively inert supporting material. While the synthesis of MFI/SiC required the presence of an additional Si-containing source, in contrast, ANA/SiC composites have been unexpectedly obtained through the self-recrystallization of the silicon contained in the α-SiC substrate. The different composite materials were thoroughly characterized by SEM, comprehensive textural and gas transport measurements and XRD. The coating rates as well as the coverage by ANA zeolite crystals on SiC surface were determined by both SEM observations and nitrogen physisorption measurements.

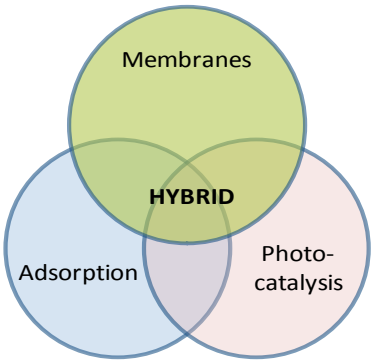


Two different approaches followed to grow zeolites on α-SiC, resulting in; (A) MFI-crystals and (B) ANA-crystals. Schematic representation of the crystal morphology at the SiC interface.

Hybride membrane process for water treatment (HYMEPRO)

(O. Šolcová, L. Matějová (member of the steering group), solcova@icpf.cas.cz, matejova@icpf.cas.cz; joint project with University of Oulu, Lappeenranta University of Technology, Corvinus University of Budapest, National University of Engineering in Lima and 12 industrial partners; supported by Finish funding agency TEKES)

Project deals with the development of a novel, active and sustainable hybrid wastewater treatment process that removes simultaneously heavy metals, arsenic and nutrients from waters. The developed technology is designed based on the green chemistry and engineering principles. [Ref. 13]



Production of 3rd generation biofuels by enzymatic catalyzed transesterification of microalgal oil

(O. Šolcová, solcova@icpf.cas.cz; joint project with EcoFuel Laboratories, TransBiodiesel, Ltd. Israel; supported by MEYS, GESHER/MOST, project No. LJ12002)

The objective of the project is to develop a closed process for autotrophic cultivation of microalgae and biorefinery approach using novel extraction techniques for production of algal oils and high-value feed additives from wet algal biomass. The oil will be further converted to biodiesel utilizing a novel immobilized enzymatic technology.

Project makes huge benefit from connecting algae cultivation and photo-bioreactor design experience together with the down-stream chemical engineering experience of Czech partners with the complementary experience of Israel partner in the area of biodiesel production. Important benefit lies in the transfer of developed algal biotechnologies to Israel where conditions of warm Mediterranean climate with high level of photosynthetic solar radiation will allow efficient year-round large-scale cultivation of algae mainly using deserted non-arable land for photobioreactors installation. In comparison, climatic conditions in Czech Republic allows for only approx. 150 days cultivation period.

The process consists of cultivation of microalgae in the novel high-rate photobioreactors using waste streams as nutrients, the novel low-energy cell harvesting techniques and lipids extraction directly from wet biomass coupled with advanced high-yield enzymatic transesterification of algal oil into biodiesel. The extraction of oil from algal biomass will be environmentally friendly, leaving residual algal biomass with high content of proteins and carotenoids, suitable for use as animal feed supplement. This biorefinery approach influences positively the feasibility of production of algal biodiesel.

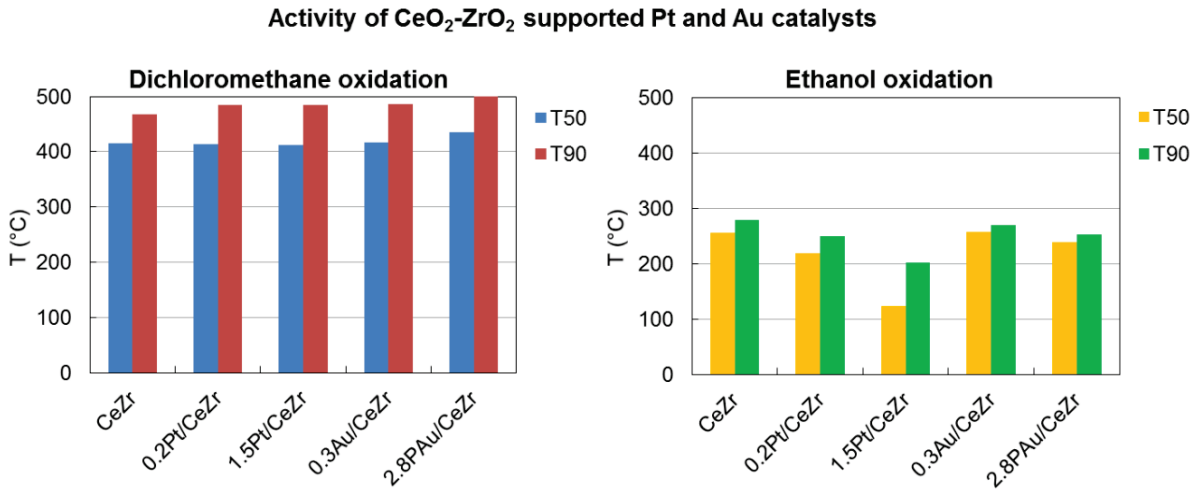
Utilization of vast knowledge of microalgae cultivation techniques and photo-bioreactor existing by partners in Czech Republic will facilitate development of techniques for production of biodiesel feedstock from algal oil. In Israel - TransBiodiesel will contribute to development of non-lipid high tolerance enzymes. Such technologically advanced enzymes will be used in a "pilot unit" for transesterification algal oil using environmentally friendly and energy saving advanced enzymatic process for 3rd generation of biodiesel production.

Pilot plant bioreactor

Washcoated ceramic monoliths for total oxidation of volatile organic compounds

(P. Topka, topka@icpf.cas.cz; supported by GACR, project No. 13-24186P)

This project is focused on the development of monolithic catalysts for total oxidation of volatile organic compounds based on ceria-zirconia mixed oxide doped by noble metals. Volatile organic compounds are one of the major contributors to air pollution and their emissions are strictly regulated by the directives of European Union. Catalytic oxidation is efficient, cost-effective and environmentally friendly way to treat VOC emissions. In industrial applications, large volumes of gases have to be treated and therefore monolithic catalysts have to be used. Ceramic monoliths are chosen due to their successful application in automotive catalysts and in the industry. The aim of the project is to propose methods for the preparation of highly active and selective monolithic catalysts and to develop the strategy for their tailored synthesis. [Ref. 15]



Activity of ceria-zirconia supported platinum and gold catalysts in the oxidation of dichloromethane and ethanol

International co-operations

Institute of Catalysis, BAS, Sofia, Bulgaria: New heterogeneous catalysts for environmental protection
University of Oulu, Oulu, Finland: New catalysts for VOC oxidation
University of Oulu, Oulu, Finland: Hybrid membrane process for water treatment
University of Paris VI, Paris, France: Theory of chemical bond
University of Poitiers, Poitiers, France: New catalysts for VOC elimination
University of Strasbourg, Strasbourg, France: Determination of transport characteristics of novel materials with hierarchical pore structure
University of Stuttgart, Stuttgart, Germany: Transport characteristics for coal gasification
Department of Chemical Sciences, University of Padua, Padua, Italy: Polymer-based catalysts
University of Maribor, Maribor, Slovenia: PolyHYPE polymers
University of Graz, Graz, Austria: Porous polymers
Silesian University of Technology, Gliwice, Poland: Transport characteristics for coal gasification
Central Mining Institute, Katowice, Poland: Transport characteristics for coal gasification
University of Barcelona, Barcelona, Spain: Ion exchanger catalysts
Zhejiang University, Hangzhou, China: Mesoporous poly(divinylbenzenes)
Institute of Surface Chemistry NAS, Kiev, Ukraine: Preparation of nanoporous materials
University of Bangor, Bangor, Wales, United Kingdom: New sensors based on optically active nanomaterials
UCG Partnership Ltd, Woking, United Kingdom: Transport characteristics for coal gasification
University of Udine, Udine, Italy: Characterization of noble metal catalysts and desulfurization on unconventional catalysts
Istanbul Technical University, Istanbul, Turkey: Synthesis and Thorough Characterization of Composite Functionalized Polymeric Nano-Structure
Institute of Computational Chemistry, University of Girona, Spain
IRD Fuel Cells A/S, Svendborg, Denmark: fuel cells electroactivity
Centre National de la Recherche Scientifique, Montpellier, France: non-carbonaceous supports, catalysts
FUMA-TECH Gesellschaft für Funktionelle Membranen und Anlagentechnologie MBH, St Ingbert, Germany: ionomers
Shanghai Jiao Tong University, Shanghai, China: ionomers and polymers
Volvo Technology AB, Göteborg, Sweden: MAE test protocols
SGL Carbon Gmbh, Meitingen, Germany: electroconductive gas diffusive layers
JRC Joint Research Centre-European Commission, Brussels, Belgium: FCH tests
TimCal SA, Bodio, Switzerland: carbon black supports

Visitors

L. Benoit, University of Strasbourg, France
M. Boltz, University of Strasbourg, France
P. Losch, University of Strasbourg, France
P. Krajnc, University of Maribor, Slovenia
J. Grabowski, Central Mining Institute, Katowice, Poland
M. Green, UCG Engineering Ltd, United Kingdom
A. Lobnik, University of Maribor, Maribor, Slovenia
A. Sezai Sarac, Istanbul Technical University Faculty of Sciences

R. Palcheva, Institute of Catalysis, BAS, Sofia, Bulgaria
K. Stanczyk, Central Mining Institute, Katowice, Poland
Y. Zub, Institute of Surface Chemistry NAS, Ukraine
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F. Mornaghini, TimCal SA, Bodio, Switzerland
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B. Bauer, FUMA-TECH, St Ingbert, Germany
W. Zhang, FUMA-TECH, St Ingbert, Germany
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J. Roziere, Centre National de la Recherché Scientifique, Montpellier, France
J.L. Bonde, IRD Fuel Cells A/S, Svendborg, Denmark
M. Odgaard, IRD Fuel Cells A/S, Svendborg, Denmark
M.J. Larsen, IRD Fuel Cells A/S, Svendborg, Denmark
D.N. Tito, Elysium Projects Ltd., Bangor, United Kingdom

Teaching

P. Klusoň: UJEP, Faculty of the Environment, course "Toxicology"
R. Ponec: CU, Faculty of Science, course "Structure and Reactivity"
O. Šolcová: ICT, Faculty of Chemical Technology, postgraduate course "Texture of Porous Solids"

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Original Papers

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