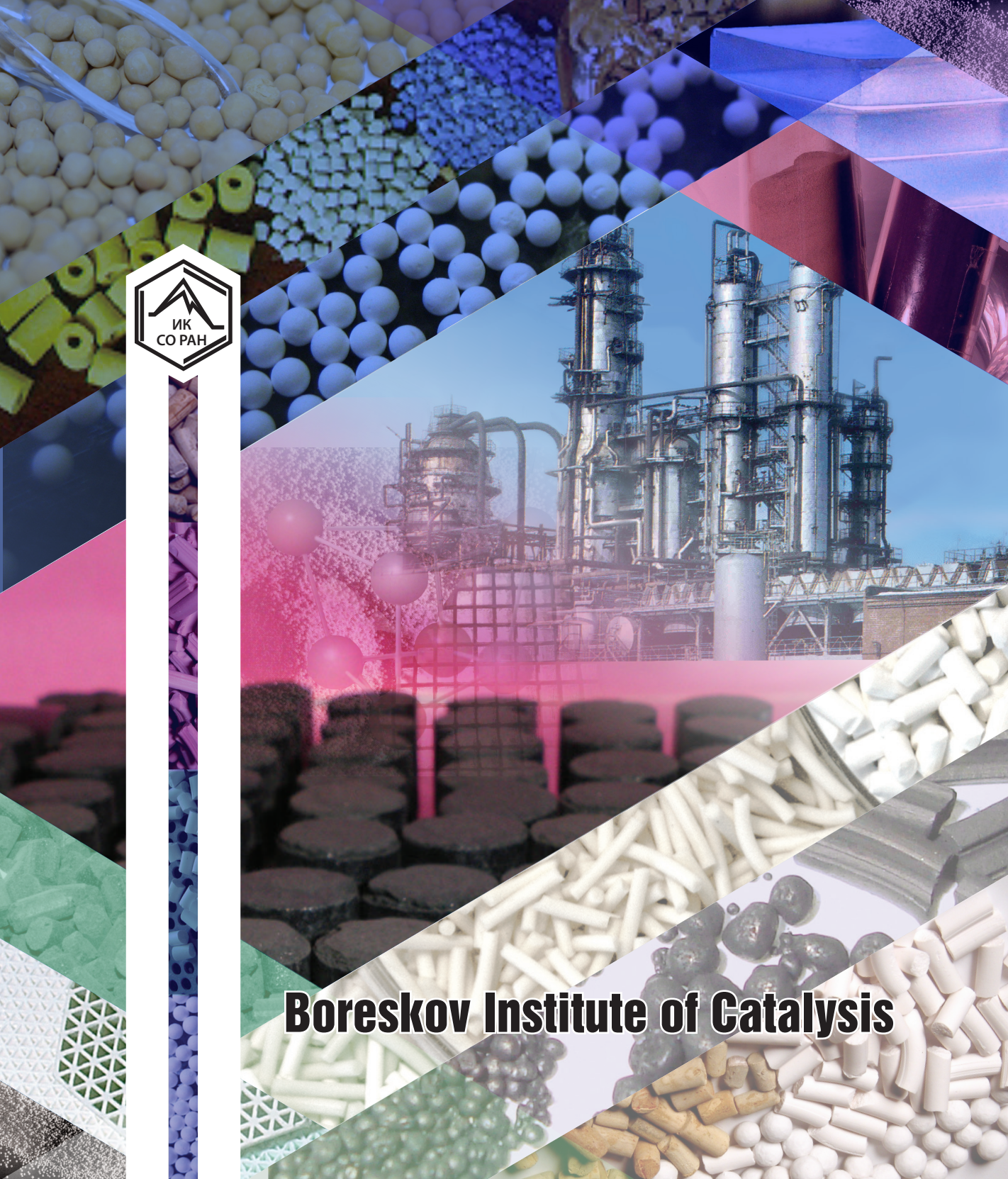

ИК
СО РАН
Boreskov Institute of Catalysis

Catalytic technologies are the structural and innovative basis of chemical industries and related economic sectors…

Prof. Valentin Parmon
Director of the Boreskov Institute of Catalysis

Catalysis is the key to hi-tech chemistry

Boreskov Institute of Catalysis is one of the largest Russian research centers in the area of catalysis.

Research focus:

Oil & Gas Processing	New generation catalysts and catalytic technologies for oil and gas refining including on-site processing
Environmental protection	Technologies for utilization of oil associated gases, treatment of industrial waste gases and wastewater
Energy Saving	Catalysts and processes for fuel production from renewable resources, for effective generation of hydrogen
New Materials	Scientific basis for meeting challenges of forthcoming decades – nanotechnologies for synthesis of functional materials with required properties including polymers and unique medical substances

Since 1958 – the date of the Institute foundation – our scientists have been committed to integrating fundamental and applied investigations to solve urgent problems of industry. BIC's proprietary catalysts, sorbents and catalytic technologies are successfully used in Russian industries and abroad. Our expertise, the modern instrumentation array and pilot-scale facilities lead us to create world level products.

Our competence

We convert knowledge into innovations

Extremely wide BIC's activity areas embrace problems from fundamentals of catalysis to innovative catalytic technologies and large-scale production of catalysts and chemicals.

Fundamental

- *In situ* investigations of catalyst structure and properties and of the mechanisms of model and practically important catalytic reactions including the reactions in supercritical fluids
- Methods and algorithms for prediction of catalytic action and catalyst activity and process selectivity
- Methods and facilities for real-time screening of catalyst performance under specified conditions
- Nanotechnological methods for deliberate design of catalysts with required properties

Our competence

R&D Activities Areas

- Catalysts and processes for generation of synthesis gas and hydrogen for hydrogen accumulators and fuel cells

- Catalysts of special shape and processes based thereon (minimization of noble metal loading)

- Gas-to-Liquid (GTL) catalytic processes for involvement of light alkanes into synthesis of olefins and liquid organic compounds

- Synthesis of polymer materials with required properties

- Methods for modification of polymers (including modification with nanomaterials), synthesis and studies of the influence of the modifiers

Our competence

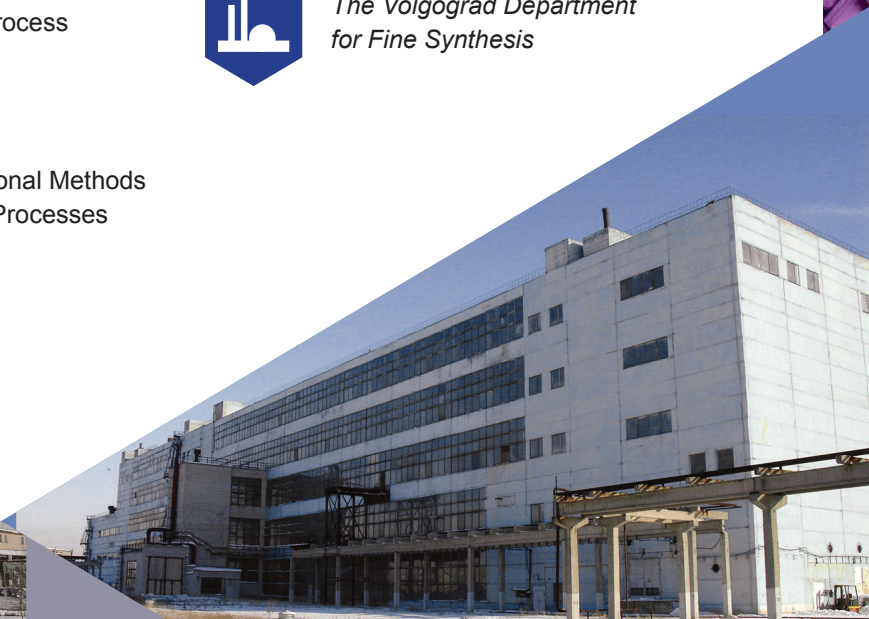
Applied catalysis

- Design of small-scale lines for manufacturing of experimental and pilot catalyst (including monolith) batches to be used for rapid scaling-up
- Design of universal technological benches (including tube and fluidized bed reactors) for testing new catalytic processes
- Catalysts and processes for sythesis of chemicals from renewable raw materials, for biomass processing
- Catalytic processes for treatment of heavy oil fractions
- Technologies for manufacturing of biodegradable polymers
- New catalytic processes for synthesis of valuable chemicals

Organization Chart

To convert scientific findings into innovative products, the Institute brings together almost 400 researchers in Departments and Laboratories.

- Department of Physicochemical Methods
- Departament of Heterogeneous Catalysis
- Department of Basic and Applied Research and Catalyst Testing
- Department of Catalytic Process Engineering
- Department of Non-traditional Methods for Catalytic Processes
- Department of Catalytic Processes of Fine Organic and Bioorganic Synthesis
- Department of Applied Catalysis
- Department of Polymer Materials (*St-Petersburg)*
- *The Volgograd Department for Fine Synthesis*



Our facilities

The available set of physico-chemical tools including proprietary *in situ* methods provide comprehensive atomic- and molecular-scale investigations of structures and properties of materials, as well as intimate mechanisms of homogeneous and heterogeneous catalytic reactions.

Computer clusters are used for quantum-chemical modeling of the geometric and energetic characteristics of catalysts, interpretation of spectral data to predict the activity of complex catalytic systems.

Developed mathematical models and methods allow reactors to be optimized and catalytic processes to be improved.

Our facilities

A powerful instrumentation array is created for pilot-scale adapting of catalytic processes. In the Department of Applied Catalysis, experimental batches (up to several t/year) of catalysts and supports different in shape and size are manufactured; modular automated pilot plants equipped with different type reactors are used for their life testing, new reactor designs and complex technological processes are optimized.

The **Volgograd Department** is equipped under the international GMP standards to adapt technologies for fine synthesis and to produce specialty chemicals on the pilot scale.

The activities of the BIC affiliated engineering company **BI Technology in St-Petersburg** are aimed at promotion and expansion of BIC's proprietary technologies and products.

Our achievements

In close cooperation with industry, we work to create cutting-edge products. More than 75 BIC's proprietary catalysts and catalytic technologies are in use at industrial enterprises in chemistry, petrochemistry, oil processing, heat and power generation, as well as for environmental protection.

Our achievements are recognized by the scientific community and annually awarded prizes, medals and diploma.

2012 New generation Klaus catalysts

2010 Catalytic heat generators

2008 Glass fiber based catalysts

2007 Microspherical catalysts for paraffin dehydrogenation

2006 Supported catalysts for olefin polymerization. Ultrahigh molecular weight polyethylene

2005
2004 New generation oil processing catalysts
In cooperation with IHP (Omsk)

2000 New technology of loading the reactors with catalysts

1997 Non-platinum catalyst for production of nitric acid

1996 Alphox technology (benzene + [N2O] → phenol)
Developed in cooperation with Solutia, USA

1993 Carbonaceous material SIBUNIT
Sibunit for phosgene synthesis, DuPont, 1994, USA

1988 Catalysts for propylene polymerization
DSM, The Netherlands, 1995

1982 REVERSE-Process
Monsanto Enviro Chem. Systems, USA 1992

1978 Vanadium catalysts for sulfuric acid production

1958


Catalysis
for sustainable progress

Oil & gas processing

Catalysts for deep hydrodesulfurization of diesel fractions and vacuum gasoil

The residual sulfur content is provided as low as 5-8 ppm in diesel fractions (EURO-4 and EURO-5 standards) and 200–500 ppm in vacuum gasoil.

BICYCLAR® – Technology for production of aromatic compounds

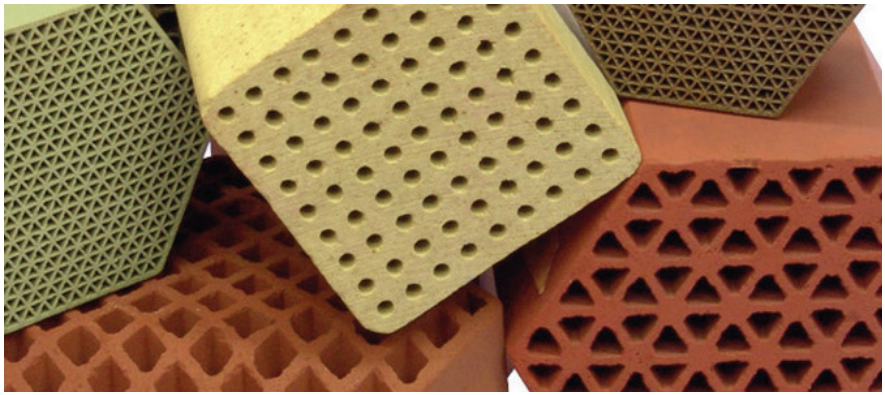
A mixture of aromatic compounds (benzene, toluene, xylene etc.) is produced from C_3–C_4 hydrocarbon fraction in the presence or in the absence of

methane over modified zeolite catalysts. The feedstock: oil associated gases, refinery waste gases, natural gas.

Key chemicals

Monolith non-platinum catalysts for oxidation of ammonia in the production of nitric acid

Partial substitution for platinoid gauzes in the ammonia oxidation reactors to decrease the platinum consumption and irrecoverable losses (by 25–40 % and 15–20 %, respectively).



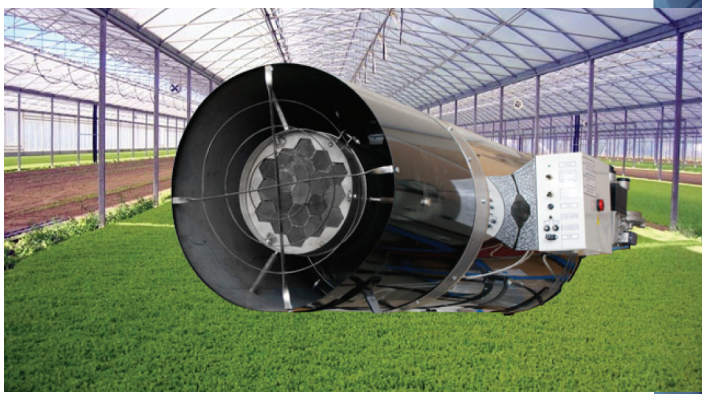
Heat power generation

Catalytic heating plants (CHP)
(in cooperation with Termosoft-Siberia Co.)

Autonomous heating and hot water supply to private, municipal and industrial buildings, farms, as well as emergency heat sources. Substitution for traditional heat power plants by principally new kind of CHP which use ecologically friendly fluidized bed catalytic burning of solid, liquid, gaseous fuel (including low-calorific fuel) at 700–750 °C. Heat power is varied from 0.25 to 12 MW.

Catalytic generators of sanitary pure hot air

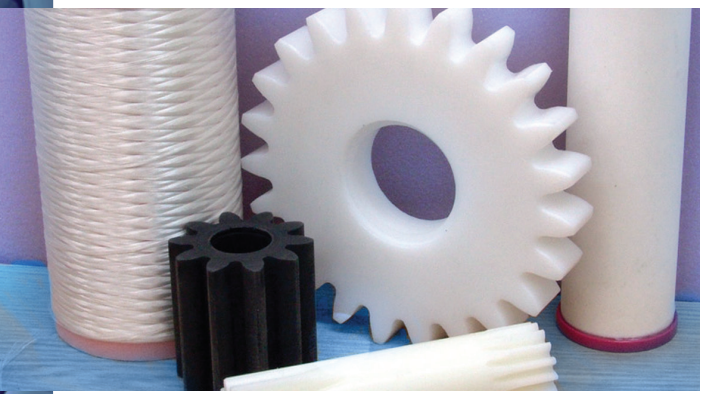
Heating of greenhouses, nondomestic storage, working and service areas based on economic and ecologically friendly combustion of liquid or gas (natural gas) fuel. Unit capacity is varied from 30 to 30,000 kW.



Polymer materials with special properties

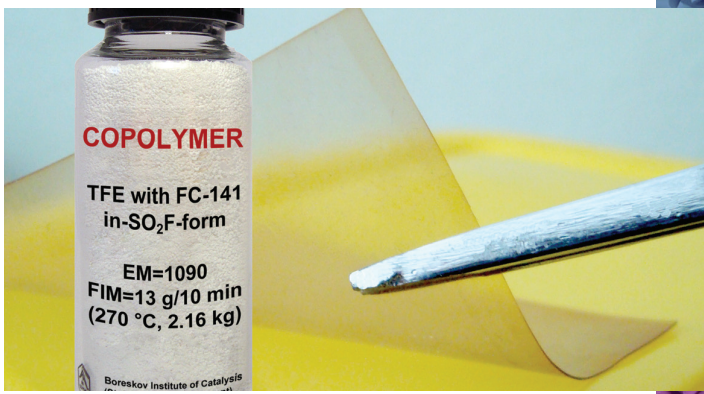
UHMWPE – Ultrahigh Molecular Weight Polyethylene

The technology is based on the new type catalyst for synthesis of ultrastrong linear polymer with unique properties (shock-, abrasion- and frost-resistance, resistance to aggressive media and γ-radiation). UHMWPE is used in numerous applications, in particular for operation under extreme conditions.



A technology for preparation of Nafion type perfluorinated membrane copolymers for fuel cells

The copolymer is synthesized through water-emulsion copolymerization of tetrafluoroethylene and sulfonyl fluoride monomer at the yield of 80–90 % (cf. 20–25 % yield observed with the traditional technology of the copolymerization in Freon solutions).



Organic and fine synthesis

Microspherical catalysts for fluidized bed dehydrogenation of paraffins

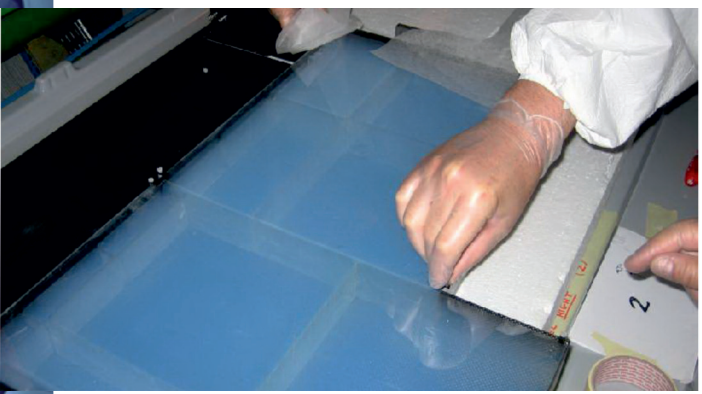
Due to their high activity and mechanical strength, the catalysts are used in Russia for large-scale dehydrogenation of isobutane to isobutylene to provide 20 °C reduction of the process temperature, a decrease in the feedstock consumption rates by 4 % and a decrease in the catalyst consumption down to 1/3 or 1/4.

Nanomaterials

Silica aerogel

Large size (200×200×50 mm) high-transparent blocks of low dense (0.03 to 0.30 g/cm^3) highly porous (80 to 99 %) aerogel.

The aerogel is fabricated in the form of blocks and spherical granules.



The blocks are used for assembling a number of aerogel detectors including:

- The Cherenkov detector of the Large Hadron Collider (CERN, Geneva);

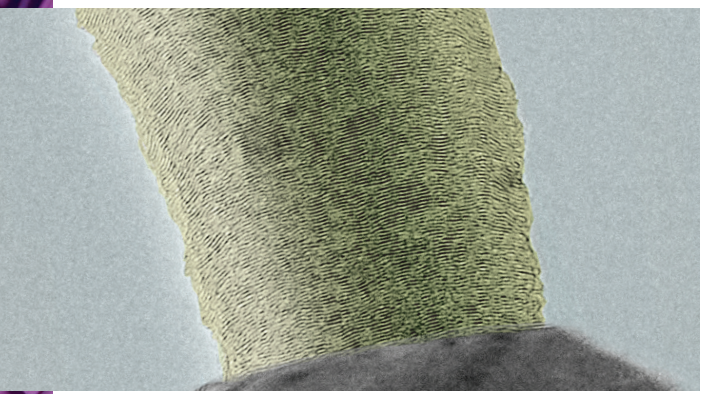
- A threshold counter of the KEDR detector (The Institute of Nuclear Physics, Novosibirsk);

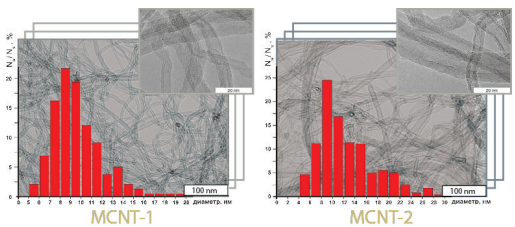
- An AMS02 detector (LPSC, Grenoble, International Space Station).

Nanomaterials

Carbon multiwall nanotubes

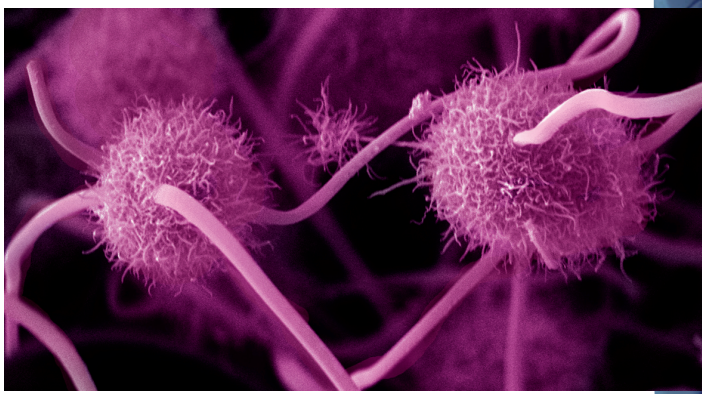
Catalytic pyrolysis of propane-butane mixture or ethylene is used to produce carbon nanotubes of no less than 95 % purity. The nanotube diameter is controlled in the range of 5 to 25 nm (5 to 20 walls). The yield is 50–100 g/g of catalyst.





Carbon nanofiber materials

Carbon nanofibers with various morphologies are synthesized by catalytic pyrolysis of oil associated gases, organic chloride waste and other C_1-C_4 hydrocarbons. The fibers are up to 0.5 mm in length and 50 to 250 nm in diameter.



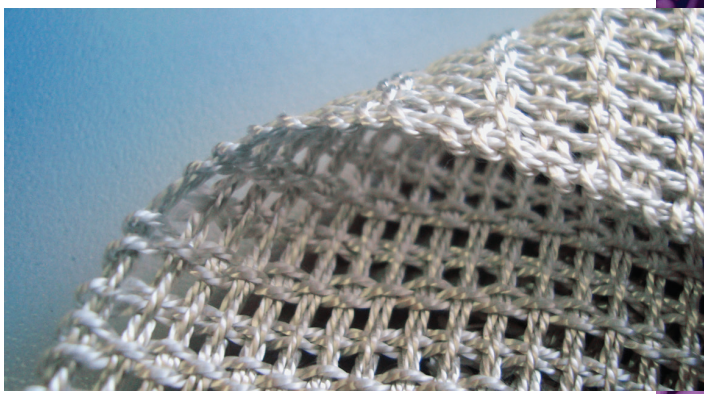
Environmental protection

Gas cleaning from hydrogen sulfide

The process is used for cleaning oil associated and natural gases, geothermal steam, refinery waste gases including hydrotreatment gas and gas from Klaus plants. Selective oxidation of H_2S to sulfur is achieved in the fixed (0.01-5% H_2S) or fluidized (5-95% H_2S) catalyst bed to utilize more than 97 % of hydrogen sulfide.

Glass fiber catalysts

The catalysts are used for cleaning of waste gases from carbon monoxide and VOC, for utilization of organic chloride waste. Advantages: low content of noble metals (0.01-0.03 wt %), resistance to catalytic poisons, mechanical strength, flexibility.

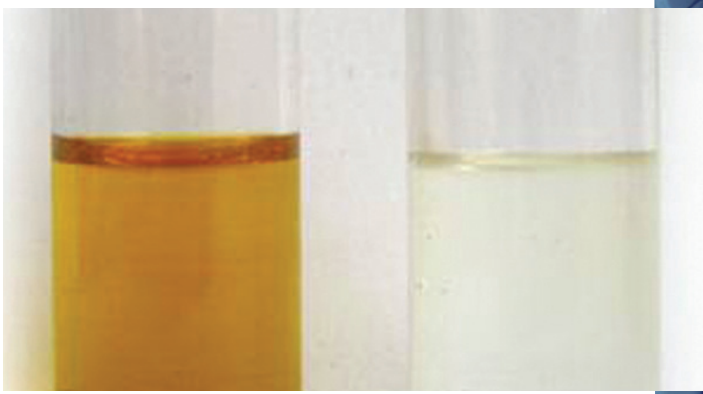


Renewable and non-traditional energy

High-cetane components of diesel fuel (green diesel)

The developed catalysts (oxide, non-sulfided) for production of hydrocarbons with cetane number more than 85 (saturated C_7-C_{17} hydrocarbons) are used in the processes:

- mild hydrocracking of plant oil and fat;
- hydrodeoxygenation of diesel biofuel.

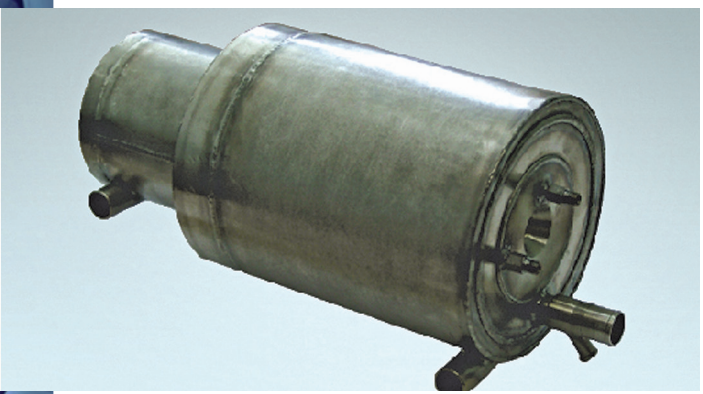


Hydrogen energy

Car-board generators of synthesis gas *in cooperation with RFNC - VNIIEF (Sarov) and Gazomotor-R LLC (Rybinsk)*

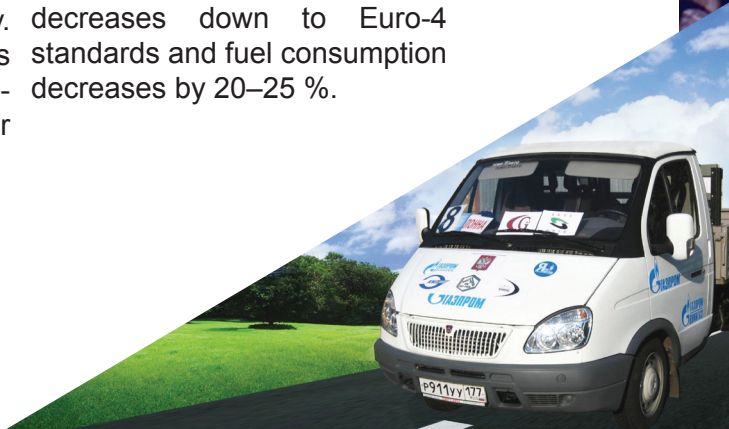
Small-size units for generation of synthesis gas from hydrocarbons (natural gas, gasoline, diesel and biofuel).

On mounting carboard, the generator gives synthesis gas as an admixture (5–10 vol %) to the fuel fed to the internal



With a small volume of the generator (8 and 16 L), the synthesis gas capacity is 5–25 and 25–50 m^3/h, respectively. One of possible applications is fuel cells in autonomous small- and medium-capacity power plants.

combustion engine. In urban driving cycle, the contents of CO and NOx in exhaust gases decreases down to Euro-4 standards and fuel consumption decreases by 20–25 %.



Hydrogen energy

Microchannel catalytic reactors for generation of synthesis gas

A variety of microreactor designs, methods for manufacturing of microchannel plates and catalyst supporting are developed. The hydrogen capacity varies from 80 L/h (T = 450 °C, steam conversion of methanol) to 430 L/h (T = 830 °C, partial oxidation of methane).

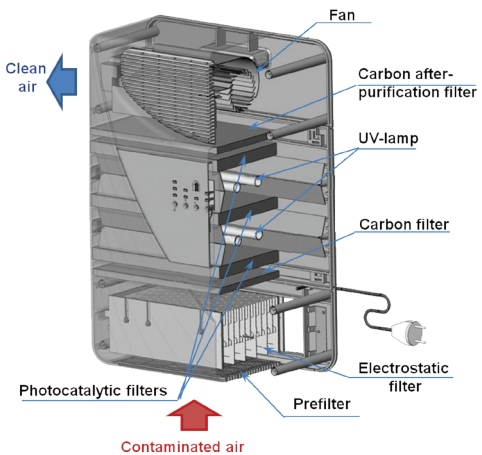
Catalytic sorptive technology for hydrogen generation

One-stage process for production of high-purity hydrogen (> 98.5 wt %) for fuel cells by combining catalytic conversion of hydrocarbons (natural gas, alcohols , propane-butane mixture) and sorptive cleaning from CO_2 in one reactor.

Catalysis for community

Photocatalytic air cleaners

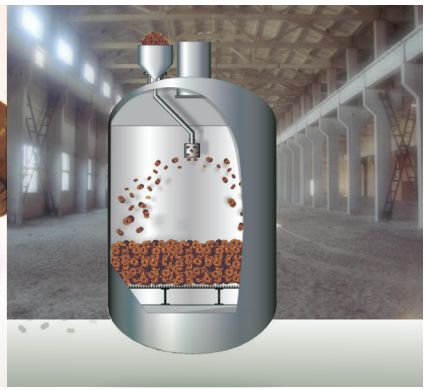
– Cleaning of air in living areas, offices, schools, libraries, hospitals
– Neutralization of toxicants and pathogenic microorganism.



Specialty equipment

Facilities for dense loading of catalysts and bulk materials

Formation of uniform filling layers of differently shaped catalyst granules in deck-type and tube reactors including reactors with radial gas inlet to provide the minimal catalyst shrinkage and a longer catalyst service cycle. The provided denser loading (8–12 %) is useful for transportation of bulk materials.



CEFLAR™ – compact-size units for heat treatment of powder materials

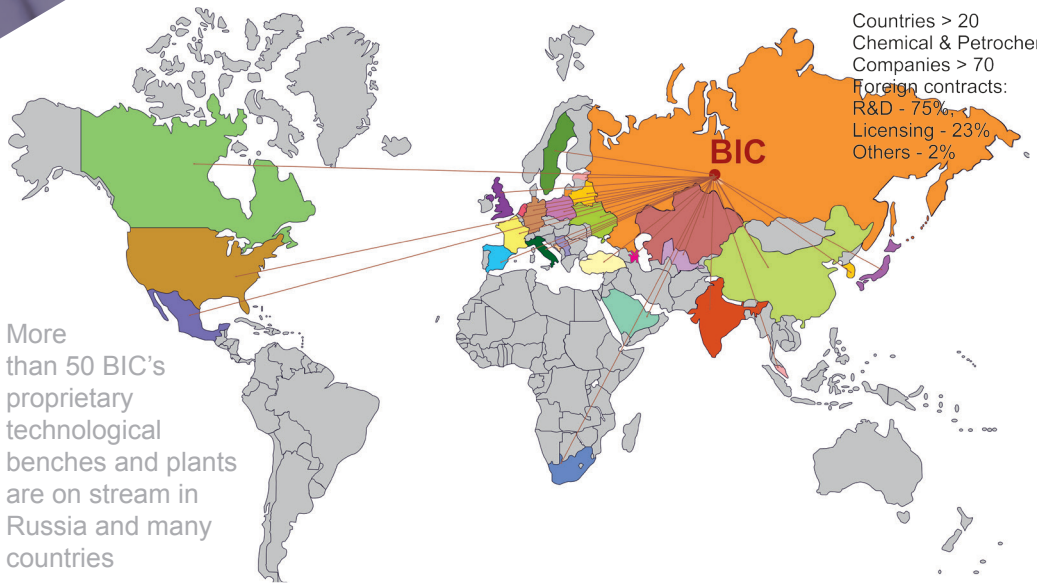
Preparation of high-reactive inorganic materials to be used for manufacturing of catalysts, supports, adsorbents etc. at the efficiency of 25 to 50 kg/h. Specifications (pilot plants): size of material particles to be treated 10 - 200 μm; time of thermoshock impact 0.5–2.0 s; powder treatment temperature up to 700 °C; specific energy consumption for thermoactivation 0.5–1.5 kW·h/kg.

Specialty equipment

Facilities for catalyst testing

Block-modular units with modern automation control systems are developed for characterization of catalytic properties of catalysts (different in shape and size) at atmospheric and high pressures in various catalytic reactions.

Scientific integration



More than 50 BIC's proprietary technological benches and plants are on stream in Russia and many countries

Boreskov Institute of Catalysis is now one of the world largest institutions specialized in R&D in the area of chemical catalysis. We work closely with leading research and producing companies. Among our Russian partners are Gazprom, Rosneft, Sibur, Nornickel.

International relations of the Institute embrace almost all continents. The Institute is involved in extremely productive scientific cooperation with companies, universities and research centers of the USA, Japan, Great Britain, Germany, France, China etc. The relations are based both on bilateral agreements under international programs and projects and on direct contracts with foreign companies.

Our scientists are participants of numerous international scientific forums, conferences, exhibitions in the area.

The Institute is the organizer or one of organizers of a number of Russian and international scientific conferences such as Chemreactor, Mechanisms of Catalytic Reactions, Biosphere Origin and Evolution, etc., and EUROPACAT XII Congress (Kazan, 2015) organized under the patronage of Rustam Minnikhanov, the President of the Republic of Tatarstan.

Educational activities

One of our highest priorities is to train young scientists. Experts of the Institute combine their research work and educational activities at the positions of professors, associate professors, senior lecturers and assistants in various universities.

State University (NSU), Novosibirsk State Technical University (NSTU), Tomsk State University (TSU), Tomsk Polytechnic University (TPU), Kazan State Technological University (KSTU), Novosibirsk State Pedagogical University (NSPU).

Each year more than 150 under- and post-graduate students have their practice at the Institute to prepare their graduate and PhD theses. These are students from largest Russian universities, among which are Novosibirsk

The talented young people help us to go ahead and to be optimistic about our future.

Contact informaiton

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