

**Academician
of Russian Academy of Sciences
Professor
Zinifer Rishatovich ISMAGILOV
50 years in Science**



Professor Zinifer Rishatovich Ismagilov was born on 15 October 1947, he graduated from Novosibirsk State University in 1969, PhD student at the Institute of Catalysis 1969-1972, Candidate of Science (PhD) in 1974, Doctor of Science 1988, Full Professor 1991, corresponding member of Russian Academy of Science 2011 and academician of Russian Academy of Science 2019.

His carrier at the Boreskov Institute of Catalysis started in 1972 as a young scientist and later succeeded as the head of the laboratory and head of the department.

In 2010 he moved to the city Kemerovo for the position of Director of the Institute of Coal Chemistry and Material Science of Siberian Branch of the Russian Academy of Sciences.

Main research areas

Professor Z.R. Ismagilov is one of the leading Russian scientists in the field of catalysis, the chemistry of carbon nanomaterials, coal chemistry, processing of fuels, materials for solving environmental problems of energy generation, environmentally friendly combustion of fuels, hydrogen energy, technologies for the transition from coal generation to hydrogen energy.

Following are seven research areas in which the most important fundamental results were obtained in the last decades in cooperation with numerous international partners.

1. Environmentally friendly catalytic combustion and energy generation. Catalytic materials and technologies.

Joint projects performed with the following partners:

- ECN – Energy Research Centre of the Netherlands
- Instituto di Ricerche sulla Combustione, Italy

- Karlsruhe Institute of Technology, Germany
- European Materials Research Society, Strasbourg, France
- Institute of Combustion Problems, Kazakhstan
- Camping Gaz, France
- Catalytic Systems Technologies Ltd, Israel

The mechanism of the hydrogen oxidation reaction by the method of kinetic isotope effect (KIEF) being pioneering, a series of studies were performed on the mechanism of total oxidation of a series of alcohols as fuels on oxide and platinum catalysts for fuel cell technologies.

New fundamental results were obtained in the study of the mechanism of heterogeneous-homogeneous oxidation reactions of various fuels (hydrogen, hydrocarbons, alcohols, amines) in the catalyst-gas phase interface by collection and direct ESR measurement of radicals.

In the early 1980s, the scientific foundations of catalytic combustion of fuels were formulated. The success in this direction was due to the development of supports and catalysts for combustion processes both in a fluidized bed and in a fixed bed.

The two-stage fuel combustion units and gas turbine chamber (200 kW) with a catalytic coating were manufactured and successfully tested with a demonstration of less than 5 ppm ultra-low emissions of CO and NO_x.

2. Clean fuels by catalytic technologies

Joint projects performed with the following partners:

- JSC "Tatneft", Russia
- Saudi Aramco Overseas, Saudi Arabia
- Sinopec Great Wall Energy and Chemical (Guizhou) Co., Ltd, China
- Delft University of Technology, the Netherlands

2.1. Purification of natural gas, associated oil gas and biogas by the method of direct catalytic oxidation of hydrogen sulfide to elemental sulfur

A new method of direct oxidation of hydrogen sulfide to elemental sulfur (DIROX) using a fluidized catalyst bed has been developed and patented in Russia and abroad. DIROX can be used at H₂S concentrations below 30%, which are not applicable to the well-known Claus technology.

The know-how for preparing new DIROX catalysts was transferred to the catalyst manufacturing plant.

A series of industrial field tests were carried out in various regions of Russia and demonstrated the high efficiency of the process with the conversion of H₂S into elemental sulfur above 99%.

Several industrial gas treatment plants were put into operation at oil fields in Tatarstan.

A fundamentally new achievement is that the DIROX technology was selected in a closed tender held by Novatek Ust-Luga LLC as more optimal in competition with one of the well-known European engineering companies. The complex of Novatek Ust-Luga LLC includes a hydrocracking plant (licensor – Royal Dutch Shell, the Netherlands), a hydrogen production plant (licensor Haldor Topsoe, Denmark) and the DIROX plant.

2.2. Hydrotreatment of motor fuels

The scientific foundations have been developed, catalysts for ultra-deep hydrotreating of fuels from dibenzothiophenes have been synthesized, investigated and patented.

2.3. Oxidative purification of fuels from sulfur compounds

In recent years, a large cycle of research has been carried out on fundamentally new technology for the oxidative purification of fuels from sulfur compounds. The successful results on efficient catalysts and technology have resulted in over international 20 patents: the United States of America, China, Singapore, Korea and the European Patent Society.

3. Solving environmental problems of power generation. Catalysts and catalytic technologies.

Joint projects performed with the following partners:

- LLNL – Lawrence Livermore National Laboratory, the USA
- ECN – Energy Research Centre of the Netherlands
- Korea Institute of Science and Technology
- Fritz-Haber-Institute, Germany
- Siemens, Germany

3.1. Nitrogen oxides (DeNO_x) removal from flue gases

3.2. Flue gas cleaning from sulfur oxides (DeSO_x)

3.3. Decarbonization – removal and processing of carbon dioxide

Monolithic honeycomb catalysts IC-44, IC-45, IC-46, IC-47 has been developed for selective catalytic reduction of nitrogen oxides with ammonia. The catalysts have been successfully tested in gas cleaning at a US Department of Energy facility. At initial NO_x concentrations of 3000-4000 ppm, purification up to 96% was achieved.

High stable catalysts based on Cu-ZSM-5 for selective catalytic reduction of nitrogen

3.4. Reduction of sulfur compounds using methane and synthesis gas

Monolithic and granulated catalysts have been successfully tested in flue gas cleaning of Vanyukov furnaces at the Copper Plant of the Polar Division of PJSC MMC Norilsk Nickel.

4. Hydrogen Energy

Joint projects performed with the following partners:

- NWO – Dutch Research Council, the Netherlands, 5 projects
- ECN – Energy Research Centre of the Netherlands
- NEDO – New Energy and Industrial Technology Development Organization, Japan
- Tezpur University, India

4.1. "Blue" Hydrogen production by steam reforming, "dry" reforming of methane, autothermal reforming and partial oxidation of natural gas and coal bed methane

4.2. Three innovative technologies of "Green+" hydrogen production, which comprise excluding any carbon oxides formation and emissions and "plus" additional production of second valuable product

- dehydroaromatization of methane: hydrogen and benzene

- methane catalytic decomposition: hydrogen and carbon nanomaterials
- hydrogen sulfide decomposition in a membrane reactor: hydrogen and elemental sulfur

5. Carbon nanofibers and nanotubes for catalyst supports and electrochemical energy storage systems

Joint projects performed with the following partners:

- NEDO – New Energy and Industrial Technology Development Organization, Japan.
- JATIS, Japan
- University of Twente, the Netherlands

5.1. Fuel cells

5.2. Supercapacitors

The systematic study of regularities of carbon nanofiber formation (CNF) in the decomposition of hydrocarbons on monometallic and alloy catalysts has been carried out, the structural and textural properties of the prepared CNF have been studied in detail. A number of CNFs have been successfully used to prepare a series of highly effective catalysts. The technology of making nanoscale platinum catalysts for fuel cells patented in Japan. A wide range of different carbon nanomaterials has been synthesized, studied and developed: CNF, N-CNF, O-CNF, O,N-CNF, MWNT, N-MCNT, O-MCNT, and O,N-MCNT with a specific surface area up to 3000 m²/g and nitrogen content up to 8%, and the stabilization of nanoparticles (2-5 nm) of both platinum and transition metals on these materials (chemical composition, surface chemistry, morphology, structure, defectiveness, etc.) recommended for electrode materials for new generation supercapacitors and other electrochemical energy storage systems.

6. Technologies to address the environmental challenges of the nuclear power industry

Joint projects performed with the following partners:

- ISTC – International Science and Technology Center, 5 projects
- LLNL – Lawrence Livermore National Laboratory, USA

6.1. Technologies of liquid radioactive waste disposal

Jointly with the top Russian fuel rods producer JSC "Novosibirsk Chemical Concentrates Plant"

(JSC "NCCP") the processing of mixed organic radioactive waste was developed. The process is based on the complete oxidation of the organic part of waste in a fluidized catalyst bed and collecting of mineralized radionuclides in ash form and converting into a compact solid form convenient for traditional processing.

A demonstration plant for the destruction of mixed organic radioactive waste contaminated with uranium oxides, with a capacity of 50 t/year, was built and successfully tested at JSC "NCCP".

6.2. Rational way of incorporation of depleted uranium compounds from waste storage deposits into high-value products methane reforming catalysts

For the first time, the phenomenon of thermal activation of uranium oxides was established. When the calcination temperature is increased to 1000 °C, X-ray amorphous nanosized uranium oxide with a certain ratio of valence states is formed which ensures high catalytic activity. The technology of production of industrial catalysts for hydrocarbon processing modified by depleted uranium oxide nanostructures was developed and patented.

7. Transition from coal-fired generation to hydrogen energy

Joint projects performed with the following partners:

- Institute of Coal Chemistry, Chinese Academy of Sciences
- Project DEMCAMER – 7th Framework Program of European Commission. Project EC FP7-NMP-2010-LARGE-4)

The transfer of coal industry raw resources from energy generation to rational methods of primary processing products (coke, semi-coke, adsorbents), gasification to gaseous and liquid products for further separation of individual chemical compounds, binders, monofibers, humates, waxes, etc. is being developed. The main direction is the production of "gray" hydrogen with simultaneous utilization of carbon dioxide into chemical products.

The problems of coal methane and the utilization of mine methane are investigated in detail. Within the DEMCAMER Program a series of catalysts for partial oxidation, dimerization and aromatization reactions of coal methane were developed. A large cycle of research on catalytic membranes and microreactors was performed.

The problems of coal methane and the utilization of mine methane are investigated in detail. Within the DEMCAMER Program a series of catalysts for partial oxidation, dimerization and aromatization reactions of coal methane were developed. A large cycle of research on catalytic membranes and microreactors was performed.

Academician Z. Ismagilov served as the organizer and scientific leader of a number of projects in the frame of Russian State Federal Programs and International and Russian Networking Projects

- 9 projects of the International Science and Technology Center, ISTC
- 7 projects of The Netherlands Organization for Scientific Research, NWO
- 2 European projects COPERNICUS
- 4 European projects INTAS
- 3 projects Japanese New Energy and Industrial Technology Development Organization, NEDO
- European Community Frame Program 7-NMP-2010-LARGE-4 Project DEMCAMER – Design and Manufacturing of Catalytic Membrane Reactors by developing new nanoarchitected catalytic and selective membrane materials, European Community, 2011-2015
- Industrial Contract "Oxidative desulfurization of petroleum fuels". Saudi Aramco Overseas Company, 2012-2015
- 15 grants of Russian Foundation for Basic Research, RFBR and RSF
- More than 17 projects in the Program of Interdisciplinary and International Research of Siberian Branch of Russian Academy of Sciences with institutes of Azerbaijan, Belarus, Kazakhstan, Ukraine and Mongolia

Academician Z. Ismagilov conducted teaching and research at Russian and foreign Universities

1978-1979 – Invited scientist at Rice University, a research project on zeolite catalysts for dehydroaromatization, Houston, Texas, USA

1977-1989 – Lecturer, Associated Professor at Chair of Physical Chemistry, Novosibirsk State University

1979-1982 – first Deputy Dean of Faculty of Natural Sciences, Novosibirsk State University

1992 – NATO Professor Fellowship at Louis Pasteur University, Strasbourg, France

1993 – Invited Professor at Northwest University and Batelle, Pacific Northwest National Laboratory, Richland, Washington, the USA

2006-2012 – Leading Researcher, Novosibirsk State University

2008 – Lecture series for PhD course at Al-Farabi Kazakh National University, Almaty, Kazakhstan "Carbon nanofibers, methods of synthesis for electrochemical energy storage systems"

2010 – Lecture series for PhD course at Al-Farabi Kazakh National University, Almaty, Kazakhstan "Nanostructured catalysts and catalytic technologies for gas processing and energy generation"

2012 – present, Head of the Chair at Kuzbass State Technical University, Kemerovo

Graduate Advisor and Thesis advisor

- More than 30 students for BS and MSc degrees.
- Successfully defended 32 PhD and 6 Doctor of Sciences theses.
- Currently, there are 5 PhD students.

Membership

Presidium of Siberian Branch of Russian Academy of Science (RAS), RAS Scientific Council on catalysis, RAS Scientific Council on the chemistry of fossil and renewable carbon-containing raw materials.

Editorial Boards

- Chemistry for Sustainable Development, Editor-in-Chief (since 2019)
- International Advisory Board, Encyclopedia of Catalysis, Editor-in-Chief Istvan T. Horvath (2002)
- Advisory Board, RSC Catalysis Book Series, Editor J James Spivey, 2008
- Editorial Board RSC Catalysis Book Series, Editor J James Spivey, 2011
- Applied Catalysis B Environmental (1998-2002)
- Eurasian Chemico-Technological Journal, Almaty, Kazakhstan (since 1999)
- Combustion and Plasmachemistry, Almaty, Kazakhstan (since 2003)
- Guest Editor, Catalysis Today v. 51, #3-4, 1999
- Guest Editor, Catalysis Today v. 144, #3-4, 2009
- Chemistry of Solid Fuels (since 2016)
- International Scientific Journal of Alternative Energy and Ecology (since 2007)
- Journal of Siberian Federal University, Krasnoyarsk, in Russian (since 2008)
- Proceedings of the Kuzbass State Technical University (since 2012)

- Proceedings of the Scientific Center for the Safety of Work in the Mining Industry (since 2016)

International activities

- Participation in numerous international conferences with plenary, oral and poster presentations:

International Congresses on Catalysis in Tokyo (1980), Calgary (1988), Budapest (1992), Baltimore (1996), Granada (2000), Paris (2004), Seoul (2008); Munich (2012); Beijing (2016). European Congresses on Catalysis in Maastricht (1995), Krakow (1997), Rimini (1999), Limerick (2001), Innsbruck (2003), Sofia (2005), Turku (2007), Salamanca (2009); Lion (2013), Kazan (2015), Florence (2017), (2019).

International and European Congresses on Environmental Catalysis in Pisa (1995), Miami (1998), Maiori (2001).

- European Material Research Society (EMRS) and International Union of Material Research Societies (IUMRS) meetings and conferences.
- Plenary lecture at the opening ceremony of EMRS Spring meeting, Lille, France, 2015.
- Invited opponent for PhD thesis defense and member of PhD graduation committee in a number of foreign universities (Utrecht, Twente, Eindhoven, Turku, Oulu, Al-Ain).
- Approximately 60 lectures at Western Universities, National Laboratories of USA and R&D Centers of industrial companies (UOP, Engelhard, Siemens, Bayer, ENI, Total, GEC ALSTHOM, Nippon Steel and others).
- The Special American Business Internship Training Program (SABIT), United States Department of Commerce, March-May 2003.
- Business Communications and Marketing Skills, University of Arizona in Tucson and Lawrence Livermore National Laboratory (LLNL), October 29 - November 4, 2006.

Prizes and Awards

1993, 2017 – Diploma of excellence of the Siberian Branch of Russian Academy of Sciences

1999, 2007, 2017 – Diploma of excellence of Russian Academy of Sciences

1999 – Merited scientist of Russian Federation from President of Russian Federation

2005 – Academician Koptyug Prize from Russian Academy of Sciences

1995, 2000 – Medals of All-Russian Science and Technology Exhibition

1997 – Medal of EUREKA Exhibition, Brussels
2008, 2017 – Gratitude of the Governor of the Novosibirsk Region,

2007 – Medal Academician V.P. Makeyev Russian Space Federation

2012 – Order of Honor of Kuzbass from Kemerovo regional parliament

2013 – Medal "70 years of the Kemerovo Region"

2016 – Honorary Member of the Academy of Sciences of the Republic of Tatarstan

2017 – Gold medal of Honorary Professor of Kuzbass

2020 – Memorial Award of Metropolitan of Moscow and Kolomna MACARY

2021 – International "GLOBAL ENERGY" prize

2021 – Science and technology prize of Russian Government
A number of awards of Russian Mendeleev Chemical Society.

Organization of Conferences

1. Initiator of the First International Seminar on Monolith honeycomb supports and catalysts, 1995, St. Petersburg, Russia; 1997, Novosibirsk, Russia; as ICOSCAR-1, 2001, Delft, the Netherlands; ICOSCAR 6, September 11-13, 2019 Bad Herrenalb, Germany).
2. Initiator and organizer of series of conferences CARBOCAT started as: I International Symposium on Carbon for Catalysis, CarboCat-I, 2004, Lausanne, Switzerland; CarboCat-II, 2006 St. Petersburg, Russia; CARBOCAT-8 in Porto, Portugal, 2018.
3. Workshop on "BLACK CARBON 2013" in frame of the Agreement on scientific cooperation between the RAS and the National Academy of Sciences of the United States in Moscow, April 2013; Kemerovo, April 2016.
4. A series of annual Russian–Kazakhstan International conferences "Coal Chemistry and environmental problems of Kuzbass", 2011-2021.

Publications

Over 1550 Russian and international publications including 600 articles in WoS international peer-reviewed journals, the citation is 5800, the Hirsch index is 35, Scopus 37 (in the Russian Science Citation Index is 11600, the Hirsch index is 44).

More than 140 patents of Russian Federation and 25 from foreign countries.