VIII. Department of Electrochemical Oxidation of Gaseous Fuels

Head: Professor Leszek Suski

At present, Department of Electrochemical Oxidation of Gaseous Fuels is the only unit of the Institute located outside of Warsaw. The Department has been established in 1990, bearing the name of Department of Molten Salts. Before 1990 the unit had a status of laboratory. The Department staff conducted physicochemical research of metal – its molten halide systems (e.g. Cd-CdX₂, K-KX, (X=Cl, Br, J) such as excess mole volume, surface tension, electric conductivity and viscosity. For this purpose a number of measurement techniques were devised such as, radiometric method of determining changes of molar volume in a two-component compound (developed in cooperation with Institute of Nuclear Technology of University of Science and Technology in Cracow). These techniques have acquired wide recognition and thanks to that the team was invited to participate in the Program of Standards for Molten Salts led by Molten Salt Data Center in Resenclear Polytechnic Institute, Troy, N.Y., USA and by the National Bureau of Standards in Washington.

Chemical and electrochemical basis of high-temperature carbonate fuel cells have become the main research topic in last years. In the last decade, the research in this scope was financed not only by the State Committee for Scientific Research but also by US – Poland Cooperation Fund II (cooperation with Gas Technology Institute, Des Plaines, Illinois) and Japanese programme NEDO (cooperation with Tohoku University, Sendai). A number of publications in the scope of chemistry and electrochemistry of molten carbonates dealt with the results of research on modelling of processes occurring in porous electrodes of fuel cell, kinetics of electrode hydrogen oxidation processes, reduction of oxygen electrode materials and acid-base equilibrium. The team of Department VIII is the only research group in Poland which has sophisticated basis and experience for laboratory realisation of fuel cells.

At present, the research conducted in the Department is directed toward processes of electrochemical oxidation of fuels at an interface electrode/high temperature solid electrolyte, for example ZrO₂ stabilised by yttrium oxides. These works have a character of electrochemical fundamental research but they were initiated by the vital problems temperature fuel cells with solid oxide electrode. In connection with an idea of one-chamber fuel cell, the investigations in the scope of thermodynamics and kinetics of methane oxidation in electrode with catalytic properties/solid oxide electrolyte systems were carried out. The special emphasis was put on system of two different electrodes in atmosphere of gaseous mixtures fuel + oxide (e.g. CH₄ + O₂). Particularly promising results have been obtained with the use of electrode materials based on perovskites and ceramic materials of mixed ion-electron conductivity based on CeO₂. An oxygen electrode in a solid polymer electrolyte will be investigated through electrochemical impedance spectroscopic method with the use of ultramicroelectrodes.

Separate research path is connected with works on simulative solving of problems in kinetics and mechanism of complex electrode processes. Alternative ways of adaptation aimed at further improvement of solutions will be investigated in the scope of a development of algorithms of computational electrochemistry.
Leszek Suski, Professor

M.Sc., 1952 – Department of Sciences – Jagiellonian University of Cracow.
Ph.D., 1957 – Department of Metallurgy, technical University of Mining and Metallurgy, Cracow.
Professor of Chemistry 1974 – Institute of Physical Chemistrys, Warsaw.
Emeritus Professor of Chemistry 2001 – Institute of Physical Chemistry, Warsaw.

Professional experience:
- 1959/60 Istituto di Fisica Chimica ed Elettrochimica del Politecnico di Milano (Professor Roberto Piontelli).
- 1970 Institute of Physical Chemistry of the Polish Academy of Sciences, Head of Department of Physical chemistry of Molten Salts (in Cracow)
- 1981 Université de Marseille, visiting professor.
- 2000 Institute of Physical Chemistry of the Polish Academy of Sciences, Head of Department of Electrochemical Oxidation of gaseous Fuels.

Professional affiliations:
- Polish Chemical Society (since 1958).
- The Electrochemical Society, Inc., (USA, since 1993).

Research areas:
Chemistry and electrochemistry of molten salts, chemistry of metal – its molten salt systems, chemistry of molten carbonates as relevant to Molten Carbonate Fuel cells, electrode processes of fuels (hydrocarbons) oxidation at solid oxide ionic conductors.

Selected papers

Total number of publications: ca 100
Lesław Bieniasz, Research Associate

M.Sc., 1980 – Department of Electrotechnics, Automation and Electronics, University of Mining and Metallurgy, Cracow
Ph.D., 1987 – Institute of Physical Chemistry of the Polish Academy of Sciences, Warsaw.
D.Sc., 2001 – Department of Chemistry, University of Aarhus, Aarhus, Denmark

Educational and training:

- 1984 – Institute of Electrochemistry of the USSR Academy of Sciences, Moscow, USSR
- 1992/1993 – Department of Chemistry, University of Aarhus, Aarhus Denmark
- 1996 – Department of Chemistry, University of Aarhus, Aarhus Denmark
- 1997 – Institute of Organic Chemistry, Tübingen University, Tübingen, Germany
- 1998 – Institute of Organic Chemistry, Tübingen University, Tübingen, Germany
- 1999 – Centre Commissariat a l’Energie Atomique (C.E.A.), Saclay, France
- 2000 – Department of Chemistry, University of Aarhus, Aarhus Denmark
- 2002 – Department of Chemistry, Saitama University, Saitama, Japan

Research areas:

Computational electrochemistry; development of computational approaches to solving problems of electrochemical kinetics, including digital simulation of transient electrochemical experiments and computer-aided electrochemical data analysis. Theory of transient methods. Formal kinetics of complex electrochemical reactions and phenomena, including electrocatalytic reactions.

Selected papers


Total number of publications: 62
Piotr Tomczyk, Research Associate

M.Sc., 1970 – Jagiellonian University, Cracow
Ph.D., 1977 – Institute of Physical Chemistry, Warsaw
D.I.C., 1980 – Imperial College of Science and Technology, London
D.Sc., 1997 – Institute of Physical Chemistry, Warsaw

Education and training:
1973 – Centre of Physical Chemistry, Bucharest, Romania
1979/80 – Imperial College of Science and Technology, London, Great Britain
1988 – Central Electrochemical Institute, Karaikudi, India
1990 – Institute of General and Inorganic Chemistry UAS, Kiev, Ukraine
1993/4 – Tohoku University, Sendai, Japan
1998/9 – Tohoku University, Sendai, Japan

Professional affiliations:
• Technical University of Mining and Metallurgy, Cracow

Research areas:
• Electrochemistry and chemistry of molten salts
• Fuel cells

Selected papers

Total number of publications: 32