

**Research Laboratory of Material and
Environmental Chemistry**

**Chemical Research Center
Hungarian Academy of Sciences**

**Annual Report
2001**

**Budapest
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INTRODUCTION

The Research Laboratory of Materials and Environmental Chemistry (RLMEC) is a non-profit oriented research institute belonging to the Chemical Research Center (CRC) of the Hungarian Academy of Sciences. Within the Center RLMEC has an autonomy as far as our scientific affairs and economic activities are concerned.

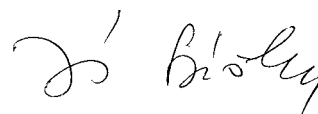
The mission of RLMEC has been formulated as follows: to perform up-to-date chemical research in materials science and technology, and also in environmental science. In materials science our research is aimed at disclosing chemical relationships among the composition, microstructure, properties and processing of selected structural materials, as models. In the field of environmental chemistry we are striving to reveal basic chemical phenomena which can be applied to decrease the environmental impact of current products and technologies on the one hand, and to develop new processes and technologies with a minimum environmental impact on the other hand.

Co-workers of RLMEC participate in the gradual and post-gradual education at various universities. Our laboratory operates a joint laboratory with the Budapest University of Technology and Economics, and a joint department with the Veszprém University.

Another important aspect of our activity is to facilitate the industrial implementation of results from academic research, and to contribute to the solution of special R&D problems of Hungarian and foreign companies.

The Annual Report 2001 holding in your hand summarizes our scientific achievements dated last year. In addition, some other aspects of our activity in 2001 are also presented in the Report.

March, 2002



János Szépvölgyi

Director

1. ORGANIZATION

Director	János Szépvölgyi, Ph.D., D.Sc.
Departments	Department of Materials Chemistry Group of Surface Chemistry Group of Electrochemistry and Corrosion Group of Plasma and Laser Chemistry Department of Environmental Chemistry Group of Environmental Technique Group of Thermal Analysis Secretariat
Staff	24 research fellows (1 OM-HAS, 5 D.Sc., 10 Ph.D.) 8 technicians 1 administrator
Address	H-1025 Budapest, Pusztaszeri út 59-67.
P.O.B.	1525 Budapest, Pf. 17.
Phone	(+36-1) 325-7896, (+36-1) 325-7900
Telefax	(+36-1) 325-7892
Homepage	http://www.chemres.hu/akkl/

DEPARTMENT OF MATERIALS CHEMISTRY

Head	János Szépvölgyi, Ph.D., D.Sc.,
Research Staff	Imre Bertóti, Ph.D., D.Sc., Scientific Advisor Éva Fekete-Dániel, Research Fellow Zoltán Károly, Ph.D., Senior Research Fellow Anna Mária Keszler, Junior Research Fellow Gabriella Lendvay-Győrik, Ph.D., Research Fellow Béla Lengyel, Ph.D., D.Sc., Scientific Advisor Gábor Mészáros, Research Fellow Ilona Mohai, Ph.D., Senior Research Fellow Miklós Mohai, Research Fellow László Nemes, Ph.D., D.Sc., Scientific Advisor Tamás Pajkossy, Ph.D., D.Sc., Scientific Advisor

Katalin A. Főglein-Szabó, Junior Research Fellow
András Tóth, Ph.D., Senior Research Fellow
Tamás Ujvári, Junior Research Fellow
Technical Staff Éva Belházy, Technician
László Gulyás, Technician
Ilona Jáger-Tardi, Technician

DEPARTMENT OF ENVIRONMENTAL CHEMISTRY

Head Gábor Várhegyi, Ph.D., D.Sc., Scientific Advisor
Research Staff Marianne Blazsó, Ph.D., D.Sc., Scientific Advisor
László Horváth, Research Fellow
György Mink, Ph.D., Senior Research Fellow
Zsuzsanna Czégény-Novák, Junior Research Fellow
Emma Pekker-Jakab, Ph.D., Senior Research Fellow
Ferenc Till, Senior Research Fellow
Technical Staff István Lengyel, Technician
Melinda Nemes, Technician
Sára Stark, Technician

SECRETARIAT

Mihály T. Beck, Ordinary Member of HAS
Borbála Zelei, Ph.D., Senior Research Fellow
Andrea Kránicz, Secretary
Gábor Babos, Mechanician
József Szűcs, Glass-shaping technician

2. RESEARCH ACTIVITIES IN 2001

Research activities of RLMEC were focused on the following topics in 2001:

Research in Materials Chemistry

- chemical transformation of solid surfaces by fast atom and ion beams,
- preparation of special ceramic powders in thermal plasma,
- research in laser chemistry and molecular spectroscopy,
- research in electrochemistry and corrosion

Research in Environmental Chemistry

- studies on the pyrolytic recycling of mixtures consisting of plastics and polymers,
- studies on the utilization of biomass materials by thermal methods,
- analysis of organic material in atmospheric aerosols,
- development of a system for the on-line analysis of coke furnace gas,
- engineering research in solar thermal area (collectors, solar desalination),
- processing of hazardous organic and inorganic materials in RF thermal plasma.

2.1. Research in Materials Chemistry

2.1.1. *Chemical transformation of solid surfaces by fast atom and ion beams*

Imre Bertóti, Miklós Mohai, András Tóth, Tamás Ujvári

Changes in the surface chemical properties of polyolefin model system and flame retarded polyolefin compound have been investigated on the effect of cold plasma treatment and also on flame treatment by using X-ray photoelectron spectroscopy (XPS) for surface analysis. It was found that a glass-like surface layer was formed in all cases which resulted in increased flame retardancy.

Ultra-high molecular-weight polyethylene was treated by fast atom beams obtained from He, Ar, H₂ and N₂. Our XPS investigations revealed formation of graphitic type material and/or hydrogenated amorphous carbon (or carbon nitride in case of treatment by N atoms) in the modified surface layer. Each treatment led to a significant increase in the surface microhardness.

CN_x layers were grown on Si(100) wafers and cleaved NaCl(100) slices by reactive sputtering of graphite in DC nitrogen-plasma, and by DC sputtering and RF magnetron sputtering of graphite, respectively. The chemical structure of deposited layers was characterised by XPS and FT-IR spectroscopy. Correlations were found between the intensity ratios of IR peaks and

that of N1s photoelectron peak components. On this basis we could identify some CN clusters of sp^2 and sp^3 -type which are discussed broadly in the relevant literature.

Papers published in 2001:

1. Szörényi T, Antoni E, Fogarassy E, Bertóti I: Dependence of nitrogen content and deposition rate on nitrogen pressure and laser parameters in ArF excimer laser deposition of carbon nitride films, *Appl. Surf. Sci.* 168, 248-250 (2000)
2. Bertóti I: Surface analysis: results and perspectives (in Hungarian), *MKL*, 56, 106-109 (2001)
3. Popok VP, Azarko II, Odzhaev VB, Tóth A, Khaibullin RI: High fluence ion beam modification of polymer surfaces: EPR and XPS studies, *Nucl. Instrum. Meth. B* 178, 305-310 (2001)
4. Ujvári T, Tóth A, Mohai M, Szépvölgyi J, Bertóti I: Composition and chemical structure characteristics of CN_x layers prepared by different plasma assisted techniques, *Solid State Ionics* 141-142, 63-69 (2001)
5. Vastag Gy, Szócs E, Shaban A, Bertóti I, Popov-Pergal K, Kálmán E: Adsorption and corrosion protection behavior of thiazole derivatives on copper surfaces, *Solid State Ionics* 141-142, 87-91 (2001)
6. Bertalan Gy, Marosi Gy, Anna P, Ravadits I, Csontos I, Tóth A: Role of interface modification in filled and flame-retarded polymer systems, *Solid State Ionics* 141-142, 211-215 (2001)
7. Ujvári T, Tóth A, Bertóti I, Nagy PM, Juhász A: Surface treatment of polyethylene by fast atom beams, *Solid State Ionics* 141-142, 225-229 (2001)
8. Kármán FH, Felhősi I, Keresztes Zs, Mohai M, Vankó Gy, Vértes A, Bertóti I, Sajó IE, Kálmán E: Effect of pretreatment of low alloy steel on oxide formation and the interaction with organic molecules, *Proc. 8th International Symposium, Passivity of Metals and Semiconductors*, (Eds Ives MB, Luo LJ, Rodda JR), The Electrochemical Society, Inc., Pennington, 2001, pp. 92-97
9. Ravadits I, Tóth A, Marosi G, Márton A, Szép A: Organosilicon surface layer on polyolefins to achieve flame retardancy through oxygen barrier effect, *Polym. Degrad. Stab.* 74, 419-422 (2001)
10. Telegdi J, Shaglouf MM, Shaban A, Kármán FH, Bertóti I, Mohai M, Kálmán E: Influence of cations on the corrosion inhibition efficiency of aminophosphonic acid, *Electrochim. Acta* 46, 3791-3799 (2001)
11. Molnár Á, Varga M, Mulas G, Mohai M, Bertóti I, Lovas A, Cocco G: Cu-Mg powders and ribbons; characterization and catalytic tests reactions, *Mater. Sci. Eng. A* 304-306, 1078-1082 (2001)
12. Mulas G, Varga M, Bertóti I, Mohai M, Molnár A, Cocco G: Characterization of Pd-Mg catalyst precursors prepared by ball milling and comparison with Cu-Mg, *Mater. Sci. Forum* 377, 57-62 (2001)

2.1.2. Preparation of special ceramic powders in thermal plasma

Zoltán Károly, János Szépvölgyi

Effects of processing conditions on the chemical and phase-composition, and also on the morphology of products formed in an RF thermal plasma reactor have been investigated in the case of Al₂O₃- and SiO₂-based, highly disperse ceramic powders. By a proper setting of synthesis conditions we could produce powders consisting of uniform, microsized Al₂O₃- and SiO₂ spheres, respectively. Particular powders have favourable sintering properties. They can be used in the chromatography, as well.

The special reaction conditions in RF thermal plasmas make possible the formation of micro-sized, hollow ceramic spheres. On the basis of our experimental results we could interpret the formation mechanism of Al₂O₃- and SiO₂-based micro-spheres. Optimum conditions of their synthesis were also determined.

By concluding our previous research on the synthesis of Si₃N₄ nanopowders, results on the atmospheric ageing of particular powders were summarized.

Papers published in 2001:

1. Károly Z, Szépvölgyi J: Plasma synthesis of hollow ceramic microspheres, In: Proc. 15th International Symposium on Plasma Chemistry, (GREMI, CNRS/University of Orléans) 2001, pp. 2775-2779
2. Szépvölgyi J, Mohai I, Gubicza J: Ageing behaviour of nanosized silicon nitride powders, J. Mater. Chem. 11(3), 859-863 (2001)

2.1.3. Research in laser chemistry and molecular spectroscopy

László Nemes, Anna Mária Keszler

Spectroscopic studies on YAG-laser induced carbon plasmas were continued. Using a new high-power YAG laser and a high resolution fibre-optic spectrometer, LIBS analyses were carried out. A new theoretical method was introduced for determining the vibrational temperature of the Swan bands of C₂ radical generated in vacuo and in helium gas, respectively.

The anharmonic vibrational effects in the IR and Raman spectra of the C₆₀ fullerene molecule were calculated by the vibrational self-consistent field approach.

Research was conducted on the theoretical analysis of the vacuum ultraviolet absorption spectra of C₃ radical in cryogenic rare gas matrices.

Papers published in 2001:

1. Nemes L, Jelski DA: Anharmonicity in the vibrational spectra of C₆₀ and its implications in laboratory spectroscopy and astrophysics, in: Spectroscopy from Space (Eds Demaison J, Sarka K, Cohen EA), NATO Science Series, Kluwer Academic Publ, Dordrecht, 2001.

2.1.4. Research in electrochemistry and corrosion

*Béla Lengyel, Tamás Pajkossy, Éva Dániel-Fekete, Gabriella Lendvay-Győrik,
Gábor Mészáros*

Electrochemical impedance spectroscopy and other electrochemical methods were applied to study some scientific problems electrochemistry as follows:

- The apparent rate coefficients of anion adsorption onto gold single crystal surfaces have been determined for various anions (sulphate, chloride, bromide and iodide) as a function of the electrode potential. In order to determine the potential of zero charge, double layer capacities were measured using Pt(111) and Pt(100) single crystals.
- Corrosion behaviour of zirconium alloys in high temperature aqueous solutions was studied and the oxide layers were characterized by using electrochemical impedance spectroscopy; results of previous measurements were re-evaluated.
- The corrosion inhibition effect of alkynols was studied using various electrochemical techniques and the results were compared with those of quantum-chemical calculations.
- We have improved our method based on the combination of electrochemical impedance spectroscopy and noise measurements to determine electrochemical kinetic parameters, both in technical and theoretical terms.

Papers published in 2001

1. Pajkossy T, Kolb DM: Double layer capacitance of Pt(111) single crystal electrodes, *Electrochim. Acta* 46(20-21), 3063-3071 (2001)
2. Nagy G, Battistig G, Csordás-Tóth A, Kerner Zs, Pajkossy T: Oxide layers of Zr1%Nb at conditions of PWR primary circuit, *J. Nucl. Mater.* 297 (1), 62-69 (2001)
3. Pajkossy T, Kolb DM.: The double layer capacitance of Pt(111) single crystal electrodes, *Proc. 5th International Symp. Electrochem. Impedance Spectroscopy, Marilleva, Italy 2001*, pp. 17-19
4. Lendvay-Győrik G, Mészáros G, Lengyel B: A simple testing method for quality control of phosphate coatings based on impedance measurements, *Proc. 5th International Symp. Electrochem. Impedance Spectroscopy, Marilleva, Italy, 2001*, pp. 168-170
5. Lendvay-Győrik G, Mészáros G, Lengyel B: EIS study of the film formation of alkynol molecules, *Proc. 5th International Symp. Electrochem. Impedance Spectroscopy, Marilleva, Italy, 2001*, pp. 259-261

6. Mészáros G, Lendvay-Győrik G, Lengyel B: An attempt for a determination of kinetic parameters combining electrochemical noise and impedance, Proc. 5th International Symp. Electrochem. Impedance Spectroscopy, Marilleva, Italy, 2001, pp. 4-6

2.2. Research in Environmental Chemistry

2.2.1. Studies on the pyrolytic recycling of mixtures consisting of plastics and polymers

Marianne Blazsó, Zsuzsanna Czégény, Emma Jakab

The interaction of different components of polymer mixtures during thermal decomposition reactions was studied. Our research was aimed at revealing the mechanism of chemical reactions of high importance for the pyrolytic recycling of polymer mixtures on the one hand, and to make clear processes which facilitate or hinder the formation of decomposition products of high environmental impact. In our experiments the effect of different compounds formed on thermal decomposition of particular polymers and their additives, respectively, on the thermal degradation of other polymers in the mixture was investigated in the temperature range of 300-900°C. Formation of volatile compounds and carbon-like products was also investigated in details by pyrolysis-GC-MS. Experiments were also performed by using thermogravimetry for the decomposition and MS for product detection.

The pyrolytic decomposition of aliphatic and aromatic polyamides proved to be influenced by hydrogen chloride eliminated from PVC under pyrolysis. The cleavage of the amide groups and the formation of volatile nitrile compounds were promoted. At high temperatures less nitriles, but considerably more hydrogen cyanide evolve from polyamides in the presence of PVC. Hindered amine light stabilisers may also be the source of organic cyanides and hydrogen cyanide during pyrolysis of plastic wastes.

The presence of wood, cellulose, lignin, charcoal and carbon black affect more or less the decomposition temperature and product distribution of synthetic polymers. The changes observed in polyolefins and vinyl polymers have been attributed to the modification of radical decomposition reactions.

Papers published in 2001:

1. Czégény Zs, Blazsó M: Thermal decomposition of polyamides in the presence of PVC, J. Anal. Appl. Pyrolysis 58-59, 95-104 (2001)
2. Blazsó M: Thermal decomposition of oligomeric and polymeric hindered amine light stabilisers, J. Anal. Appl. Pyrolysis 58-59, 29-47 (2001)
3. Jakab E, Blazsó M, Faix O: Thermal decomposition of mixtures of vinyl polymers and lignocellulosic materials. J. Anal. Appl. Pyrolysis 58-59, 49-62 (2001)

2.2.2. Studies on the utilization of biomass materials by thermal methods

Gábor Várhegyi, Emma Jakab, Ferenc Till

Plants improved for energy production were studied by thermogravimetry, thermogravimetry – mass spectrometry and by reaction kinetic analysis in inert gas flow, as well as in the presence of oxygen. The temperature programs were composed of non-isothermal and isothermal sections, to gain information in a wide range of experimental conditions. The samples included *poplars*, *acacia*, *willow* and *Micanthus sinensis*. Similarities and differences observed and interpreted in the behaviour of particular samples. Approximate kinetic models were employed to determine the behaviour of main components (cellulose, hemicellulose, lignin and extractive materials) during decomposition/thermal oxidation. A simple model was developed found for describing the behaviour of softwood and hardwood alike at non-isothermal heating.

Papers published in 2001:

1. Simkovic I, Jakab E: Thermogravimetry/mass spectrometry study of weakly basic starch-based ion exchanger, *Carbohydr. Polym.* 45, 53-59 (2001)
2. Tam MS, Antal MJ Jr, Jakab E, Várhegyi G: Activated carbon from macadamia nut shell by air oxidation in boiling water, *Ind. Eng. Chem. Res.* 40, 578-588 (2001)
3. Várhegyi G, Szabó P, Antal MJ Jr, Dai X: Kinetic modeling of the gasification of biomass charcoals, *Proc. 1st World Conf. Exhibition on Biomass for Energy and Industry*, (Eds Kyritsis S et al) Volume 2, James & James Science Ltd, 2001, pp. 1783-1785
4. Várhegyi G, Szabó P, Jakab E, Till F: Least squares criteria for the kinetic evaluation of thermoanalytical experiments. Examples from a char reactivity study, *J. Anal. Appl. Pyrol.* 57, 203-222 (2001)
5. Várhegyi G, Till F, Jakab E, Szabó P: Combustion and gasification properties of fossil and renewable fuels studied by thermal analysis, *Proc. Joint Symposium (Korea/Hungary) on Energy and Environmental Technology for the 21th Century* (Ed Kim SD) Korean Institute of Science and Technology, Daejon, Korea 2001, pp. 169-192

2.2.3. Analysis of organic material in atmospheric aerosols

Marianne Blazsó

The organic carbon content of fine aerosols plays an important, yet not determined role in the atmospheric processes. The organic material in topospheric aerosols has been studied in cooperation with the University of Veszprém (Hungary) by thermally assisted hydrolysis and methylation, coupled with GC/MS. The results suggest that a considerable portion of particular polymer in rural aerosols collected in summer can be regarded as natural humic matter directly emitted by biogenic sources.

Papers published in 2001:

1. Gelencsér A, Mészáros T, Blazsó M, Kiss Gy, Krivácsy Z, Molnár A, Mészáros E: Structural characterisation of organic matter in fine tropospheric aerosol by pyrolysis-gas chromatography - mass spectrometry, *J. Atmosph. Chem.* 37, 173-183 (2000)

2.2.4. Development of a system for the on-line analysis of coke furnace gas

György Mink, László Horváth,

A monitoring system has been developed previously for the analysis of coke furnace gas. Particular system consists of two GC columns. The light permanent gases (H_2 , O_2 , N_2 , CH_4 , CO) in the coke furnace gas are separated on molecular sieve charge, while the heavier components (CO_2 , H_2O , the C_2 - C_5 and aromatic hydrocarbons, as well as the harmful impurities like H_2S , NH_3 and HCN) are separated by Porapak-R, using He as carrier gas. Components above 0.1% concentration are determined by TCD, and the minor components (1-1000 ppm) are measured by HID.

Based upon the large body of experimental information obtained under long term loading in industrial conditions, the monitoring system has been improved significantly in 2001. It resulted in a more accurate analysis of hydrogen: now the H_2 content of coke furnace gas can be determined with accuracy of 1 relative %. Improvement of the peripheral hardware and the optimisation of the measuring and regeneration cycles, the need for the preventive maintenance, fine-tuning and re-calibration could be reduced by about 50%. Simultaneously, He of medium purity can be used instead of high purity He.

Nowadays the composition and calorific value of flue gas is determined every hour. It is a reliable indicator of the performance of coke furnaces for the Plant management. In addition, the efficiency of Gas Cleaning Plant is also screened every hour by the determining the concentration of harmful minor components (H_2S , NH_3 , HCN).

It is worthwhile to mention that the price of gas is based now on the daily average calorific value determined by the monitoring system. The new price is accepted by the consumers, though it is somewhat higher than the previous one. Thus, operation of the monitoring system results in about 100 million HUF additional annual incomes to the Plant.

Papers published in 2001:

1. Mink Gy, Horváth L, Hári L.: Development of air pollution control system in a Hungarian iron and steel works, *Proc. Joint Symposium (Korea/Hungary) on Energy and Environmental Technology for the 21th Century* (Ed Kim SD) Korean Institute of Science and Technology, Daejon, Korea 2001, pp. 39-56

2.2.5. Engineering research in solar thermal area

György Mink, László Horváth

Based on the analysis of heat and mass transport occurring in our laboratory scale models, a prototype of a cheap, but efficient, plastic-based, flat-plate solar collector has been developed. The outdoor testing was started in co-operation with the Technical College of Dunaújváros.

In co-operation with the University of Cagliari a concept has been developed for producing fresh water from swallow saline waters, i.e., from the abandoned basins of the former salt plant nearby Cagliari. The new technology has been tested under laboratory conditions. On the basis of engineering research with the help of solar simulator, the main design parameters and the optimum operational conditions of a desalination plant module have been determined both in terms of productivity and economic feasibility. According to performance studies and economic assessment, the module which exploits all advantages offered by the target area decreases the costs of solar desalination by nearly 50%.

2.2.6. Processing of hazardous organic and inorganic materials in RF thermal plasma

János Szépvölgyi, Katalin A. Főglein, Ilona Mohai, Zoltán Károly

Thermodynamic calculations were performed on the thermal degradation of CH_ACl_B - and CF_XCl_Y -type compounds in the presence of argon and oxygen, respectively.

Decomposition of CCl_4 és CH_2Cl_2 has been investigated in details in cold and thermal plasmas, respectively. Reactions were studied in both oxidative and neutral conditions. Formation of highly disperse soot was observed in the thermal plasma reactor, in neutral conditions. About 50 polycyclic aromatic compounds were identified by MS in the toluene extract of the soot. Comparison of thermodynamic calculations with the experimental results made possible to interpret the mechanism of soot formation.

It has been proved that the highly disperse soots of different origin took part in Diels-Alder reactions with cyclo-pentadiene in relatively mild conditions.

We continued our previous research on processing of wastes from steelmaking in thermal plasmas in 2001, as well. Inverse zinc ferrites and zinc-ferro-ferrites with excellent magnetic properties were produced by the thermal plasma treatment of steelmaking dusts in oxidative conditions. These products are valuable raw materials in the electronic industry. Zinc ferrites formed in thermal plasma conditions exhibited remarkable adsorption capacities for sulphur. Thus, they can be used for treating flue gases of high sulphur content.

Experiments were performed on vitrifying steelmaking dust and sludge from hot galvanizing in arc plasmas, in order to transform particular hazardous wastes into valuable products of low

environmental impact. From both wastes glassy materials could be produced by using suitable additives of glass formation. Optimum conditions of glass formation have been determined. The vitrified products meet the requirements of standard leaching tests, and they can be regarded as non-hazardous materials. They can be used e.g. as tiles in the building industry.

Papers published in 2001:

1. Főglein KA, Szépvölgyi J: Decomposition of halogenated hydrocarbons in silent electric discharge, Proc. 15th International Symposium on Plasma Chemistry, (GREMI, CNRS/ University of Orléans) 2001, pp 3047-3052
2. Szépvölgyi J, Főglein KA: Decomposition of hazardous organic compounds in RF thermal plasma, Proc. 15th International Symposium on Plasma Chemistry, (GREMI, CNRS/ University of Orléans) 2001, pp 2091-2097
3. Beck MT, Szépvölgyi J, Szabó P, Jakab E: Heterogeneous Diels-Alder reaction between cyclopentadiene and different solid carbons, *Carbon* 39(1), 147-149 (2001)
4. Mohai I, Szépvölgyi J, Károly Z, Mohai M, Tóth M, Babievskaya IZ et al: Reduction of metallurgical wastes in an RF thermal plasma reactor, *Plasma Chemistry and Plasma Processing*, 21, 547-563 (2001)
5. Mohai I, Szépvölgyi J, Bertóti I, Mohai M, Gubicza J, Ungár T: Thermal plasma synthesis of zinc ferrite nanopowders, *Solid State Ionics*, 141-142, 163-168 (2001)

3. PARTICIPATION IN NATIONAL RESEARCH PROJECTS

Hungarian Scientific Research Fund (OTKA)

- XPS study of the stability of supramolecular Langmuir-Blodgett systems (T025789)
- Surface modification of polyethylene by low energy inert and reactive ion beams (T029733)
- Preparation of solid catalysts by structural and surface modification and their applications in transformations of organic compounds (T030156)
- Investigations on layer structures containing C_3N_4 and CN_x phases (T030424)
- Investigation of mechanical properties of modified surface layers (T030833)
- Spectroscopic studies of isolated fullerene molecules and their laser synthesis (T026268)
- Spectroscopic and quantum chemical studies of small, carbon-containing molecules in carbon plasmas (T032549)
- Synthesis of nanosized ceramic powders and modification of their morphology in thermal plasma (F29731)
- Electrochemical Impedance Spectroscopy extended to medium amplitude perturbation and its application to corrosion research (T29727)
- Study of relaxation processes at metal/electrolyte interfaces (T030150)
- Interaction of thermal decomposition reactions in polymer mixtures (T033111)
- Thermal decomposition of wood in the presence of additives (T25341)
- Developing and applying high performance methods of thermal analysis in environmental chemistry (T25347)
- Development of new MINP models for mass transfer networks (F035085)
- Studies on the decomposition of hazardous wastes in thermal plasmas (T32272)
- Studies on the thermal decomposition of hazardous, polychlorinated organic compounds in high temperature thermal plasmas (T29734)

Other Hungarian Research Grants

- Development of long-lasting prosthesis for human hip-joints (NKFP 1/013/2001)
- Development of marketable products of low environmental impact and environmental research in the aluminium industry (NKFP 3/035/2001)
- Investigations to enhance the optimal utilization of biomass fuels (Ministry for Environmental Protection)
- Measurement system applicable for the comprehensive research of hybrid separation processes (OM-02335/2001)

4. PARTICIPATION IN INTERNATIONAL RESEARCH PROJECTS

Research Projects of the European Community

- New surface modified flame-retarded polymeric systems to improve safety in transportation and other areas (FLAMERET) (EU FP5 - G5RD-CT-1999-00120)
- Process integrated thermal chemical treatment of halogens containing materials as source of halogens free fuels for steel production and residues for noble metal recovery (HALOCLEANCONVERSION) (EU FP5 - G1RD CT 1999 00082)
- Novel arc plasma process for the decomposition of hazardous wastes and for the simultaneous production of valuable building materials (WASTILE) (EU FP5 - GRDI-2000-25035)

Other International Research Projects

- Hard coatings for high-temperature industrial applications (Mining University of Leoben, Austria)
- Determination of the zero charge potential of Pt(111) electrodes (Ulm University, Germany)
- Cooperative research in laser spectroscopy (Rose-Hulman Institute of Technology, USA)
- Cooperative research in plasma chemistry (Institute of Inorganic Chemistry RAS, Russia)
- Production of charcoal and active carbon from biomasses (Institute of Natural Energy, USA)
- Thermal decomposition of polymeric wastes (University of Okayama, Japan)
- Solar desalination of swallow saline waters (University of Cagliari, Italy)

5. PARTICIPATION IN UNIVERSITY EDUCATION

Cooperation with the Budapest University of Technology and Economics

RLMEC, along with the BUT operates the basic laboratory of the education of surface engineers in Hungary. Co-workers of RLMEC participate in the university education at the Departments of Physical Chemistry and Chemical Technology in the following fields:

- Introduction to materials science (lecture course, Imre Bertóti)
- Electronics and instrumentation (lecture course, Tamás Pajkossy)
- Electronics and measurement techniques (lecture course, Tamás Pajkossy)
- Advanced ceramic materials (lecture course, János Szépvölgyi)
- Electronics laboratory course (Gábor Mészáros)

Cooperation with the Veszprém University

Since March 1999 RLMEC is functioning as the Co-department of the Department of Silicate and Materials Engineering of the Veszprém University. In this position RLMEC actively participates in the gradual and post-gradual education of materials engineers by lecturing on

- Advanced ceramic materials (lecture course, János Szépvölgyi)
- Plasma chemistry (laboratory course, Ilona Mohai, Zoltán Károly)

Cooperation with other universities

Co-workers of RLMEC participate in the gradual and post-gradual education of chemists at the Eötvös Loránd University, Budapest. The RLMEC staffs deliver lectures also at the Technical College of Dunaújváros. Topics of lecturing cover

- Laboratory course in physical chemistry (Gábor Mészáros, Eötvös Loránd University)
- Direction of Ph.D. thesis (Marianne Blazsó, Eötvös Loránd University)
- Renewable Energy (György Mink, Technical College of Dunaújváros)

6. TRAVELS AND VISITORS

Visitors

- I. Babijevszkaja, IONH, Moscow, Russia
- M.B. Morsi, CMRDI, Cairo, Egypt
- G. A. Somorjai, P. J. Stang, J. A. Rabo, International Advisory Committee, USA
- S. Suhai, International Advisory Committee, Germany
- A. Kolitsch, Forschungszentrum Rossendorf, Dresden, Germany
- C. Mitterer, Montanuniversität Leoben, Austria
- H. Kim, K. J. Lee, E.-C. Jang, A. V. Lazarev, Samsung Advanced Institute of Technology and Samsung Electronics, Daejeon, South Korea
- K. Short, Australian Nuclear Science and Technology Organisation, Sydney, Australia.
- T. Bell, Birmingham University, UK
- Z. Kolozsváry, Plasmaterm, Tirgu Mures, Romania
- D. Smallwood, D&A Technology, Wartling, UK
- M. Cazacu, C. Racles, Institute of Macromolecular Chemistry, Iasi, Romania
- Prof. F. Floris, University of Cagliari, Italy
- G. A. Scarpa, University of Cagliari, Italy
- Dr. M. Bertolo, University of Cagliari, Italy

Scientific Travels of the Research Staff

- Imre Bertóti - E-MRS Conference, Strasbourg, France.
- Imre Bertóti - 6th Int. Workshop on Plasma Based Ion Implantation, Grenoble, France.
- András Tóth – Meetings of FLAMERET project, Poznan, Poland, Alessandria, Italy, and Uxbridge, UK.
- Imre Bertóti – Project committee meeting, Helsinki, Finland.
- Imre Bertóti, Miklós Mohai - ECASIA'01, Avignon, France.
- Marianne Blazsó – EC project meeting, Karlsruhe, Germany and Torino, Italy
- László Nemes - 56th Ohio State University International Symposium on Molecular Spectroscopy, Columbus. Ohio, USA
- Katalin A. Főglein, Zoltán Károly, Ilona Mohai, János Szépvölgyi – ISPC'15, Orléans, France

- Gabriella Lendvay-Gyórik, Gábor Mészáros, Tamás Pajkossy - 5th International Symp. on Electrochem. Impedance Spectroscopy, Marilleva, Italy
- György Mink – Conference Energia e Acqua nelle Isole, Sassari, Italy
- László Nemes – 17th Colloquium on High Resolution Molecular Spectroscopy, Papendal, Holland
- László Nemes - 56th Ohio State University International Symposium on Molecular Spectroscopy, Columbus, Ohio, USA
- Tamás Pajkossy - Ulm University, Germany
- Emma Jakab – Visiting scientist, Okayama University, Japan
- Gábor Várhegyi – Ecopole 2001 Conference, Jamrozowa Polana, Poland
- Gábor Várhegyi – Joint Symposium (Korea/Hungary) on Energy and Environmental Technology for the 21th Century, Daejon, Korea
- János Szépvölgyi – WASTILE project meeting, Valencia, Spain
- János Szépvölgyi – Joint Symposium (Korea/Hungary) on Energy and Environmental Technology for the 21th Century, Daejon, Korea
- János Szépvölgyi – EU project committee meeting, Brussels, Belgium

7. INDUSTRIAL R&D PROJECTS

AKZO-NOBEL Coatings Ltd.

Characterization of AKZO paint systems

BGT Hungaria Kft.

Treatment of ground water contaminated with molybdate ions

CORROCONT Ltd.

Studies on corrosion in soils

DUNAFERR Rt.

Development of monitoring system for environmental protection

DUNAFERR Rt.

Treatment of metallurgical wastes in thermal plasmas

GE Hungary Co.

R&D on various technological problems

Electrical characterisation of gas-discharge lamps and software development

Henkel Hungary Ltd

Qualitative analysis of polymeric material of flocculants by analytical pyrolysis

ICI Autocolor Ltd

Characterization of automotive paints

MAGYAR LAKK Ltd.

Characterization of industrial and commercial paints

MÄDER HUNGÁRIA Ltd.

Characterization of paints for different applications

NABI North American Bus Industries Ltd. Co.

Comparison of coatings developed from different paints of low solvent content

PREMIS Technology

Spheroidisation of ceramic particles in plasma

Schaefer Kalk

XPS investigation of stearic acid-covered calcium carbonate fillers

TRILAK HAERING Paint Factory

Characterization of industrial and commercial paints

8. RESEARCH FACILITIES

Department of Materials Chemistry

- X-ray photoelectron spectrometers (Kratos XSAM 800, VG ESCASCOPE)
- Fast atom beam treatment facility
- RF glow discharge treatment facility
- ICP-AES spectrometer (Baird PSX7521)
- High temperature reactors for gas-solid reactions
- RF induction plasma systems (Linn, Tekna)
- Pulsed atmospheric pressure (TEA) CO₂ laser
- Gadolinium garnet (GGG) pulsed mini-laser
- Mini-spectrometer with fibre optics (Ocean Optics PC2000)
- Quantel Brilliant YAG laser system
- High-resolution fibre optic spectrometer (Ophir Optronics, WaveStar U)
- Potentiostatic and potentiodynamic measuring facilities
- Galvanostatic and galvanodynamic measuring facilities
- Electrode impedance spectroscopy (EIS)
- Harmonic analysis
- Determination of corrosion rate in high-resistance systems
- Measurement of electrochemical noise, FFT analysis
- Evaluation of the corrosion resistance of paint layers
- Rapid corrosion resistance tests
- Methods for the evaluation of lifetime and paint-technological properties of coatings

Department of Environmental Chemistry

- Thermobalance-mass spectrometer system (Hiden Hall 300 PCI, Perkin-Elmer TGS-2)
- High pressure thermobalance (Hiden Hall IGA, high temperature furnace)
- Reactive thermobalance (Mettler)
- Analytical pyrolysers (Chemical Data Systems, Pyroprobe 2000)
- Gas chromatograph-mass spectrometer system (HP 5985B)
- Gas chromatograph (HP 5880A)
- Laser-diffraction particle size analyzer (Malvern 2600C)
- Fourier transform infrared spectrometer (Perkin Elmer 1700)

- Volumetric adsorption system for studying adsorption and chemisorption
- Differential scanning calorimeters (Setaram DSC 111, Perkin Elmer DSC 2)
- Solar still simulator
- Two-column GC with automatic dosing system (Perkin-Elmer Autosystem XL)

9. E-MAIL ADDRESSES, PHONE NUMBERS

NAME	E-MAIL	PHONE
Mihály T. Beck	beckmt@chemres.hu	325-7933/235
Imre Bertóti	bertoti@chemres.hu	325-8147
Marianne Blazsó	blazso@chemres.hu	438-4140
Zsuzsanna Czégény	czegeny@chemres.hu	325-7933/381
Éva Dániel-Fekete	efekete@chemres.hu	325-7933/213
Katalin A. Főglein	fogleink@chemres.hu	325-7933/415
László Gulyás	gula@chemres.hu	325-7933/578
László Horváth	lhorvath@chemres.hu	325-7933/451
Zoltán Károly	karoly@chemres.hu	325-7933/415
Anna Mária Keszler	akeszler@chemres.hu	325-7933/488, 306
Andrea Kránicz	kranicz@chemres.hu	325-7896
Gabriella Lendvay-Győrik	gyorik@chemres.hu	325-7933/163
Béla Lengyel	blengyel@chemres.hu	325-6992
Gábor Mészáros	meszaros@chemres.hu	325-7933/213
György Mink	mink@chemres.hu	325-5992
Ilona Mohai	mohaiti@chemres.hu	325-7933/415
Miklós Mohai	mohai@chemres.hu	325-8147
László Nemes	nemesl@chemres.hu	325-7933/287, 306
Emma Pekker-Jakab	jakab@chemres.hu	325-7933/381
Tamás Pajkossy	pajkossy@chemres.hu	325-7933/230
János Szépvölgyi	szepvol@chemres.hu	325-7896
Ferenc Till	till@chemres.hu	325-7933/280
András Tóth	totha@chemres.hu	325-8147
Tamás Ujvári	t-ujvari@chemres.hu	325-7933/578
Gábor Várhegyi	varhegyi@chemres.hu	438-4140
Borbála Zelei	zelei@chemres.hu	325-7933/488