

## DEPARTMENT OF ANALYTICAL CHEMISTRY

Head of Department:

Prof. Jozef Lehotay, PhD, DSc.

E-mail:

Telephone: ++42-7-52926043

Fax: ++42-7-52926043

lehotay@cvt.stuba.sk

### I. STAFF

Full Professors :

Dušan Bustin PhD, DSc; Ján Krupčík, PhD, DSc, Jozef Lehotay, PhD, DSc., Ján Mocák, PhD, DSc

Associate Professors :

Ernest Beinrohr, PhD, Eva Brandšteterová, PhD, Miroslav Čakrt, PhD, Ján Labuda, PhD, Eva Matisová, PhD, DSc, Drahomír Oktavec, PhD, Miroslav Rievaj, PhD, Jozef Polonský, PhD, Viktor Vrábel, PhD

Assistant Professors :

Eva Benická, PhD, Tatiana Buzinkaiová, PhD, Andrea Hercegová, Elena Korgová, PhD, Jarmila Laštincová, Pavol Májek, PhD, Alena Manová, PhD, Pavol Tarapčík PhD, Mária Vaničková, PhD

Reader :

RNDr. Magdaléna Valachovičová

Research Fellows::

Miriám Bučková, PhD, Ján Dzurov, Adriana Ferancová (from 1.10.2000), Katarína Hroboňová, PhD, Pavol Kubalec, PhD, Jana Sádecká, PhD, Ivan Skačáni, PhD, Ivan Špánik, PhD, Peter Tomčík, PhD

PhD Students:

Branko Balla, Alica Čaniová, Jana Ďungelová (from 1.10.2000), Peter Korytár, Petra Kotianová (from 1.10.2000), Peter Oswald

Technical staff :

Ladislav Bartalos, Danuša Bartalosová, Marta Benešová, Zuzana Cifrová, Ing. Jana Otrubová

### II. TEACHING AND RESEARCH LABORATORIES

Laboratory of capillary gas chromatography

Laboratory of high performance liquid chromatography

Laboratory of electroanalytical methods

Laboratory of molecular spectrometry

Clean laboratory for trace analysis with atomic spectrometry (AAS, OES-ICP)

Laboratory of organic elemental analysis

Laboratory of organic synthesis

Laboratory of fluorescence analysis

Laboratory of capillary isotachopheresis

Laboratory of electrochemical pre-concentration for atomic spectroscopy

Laboratory of chemometry

Laboratory of bioanalytical chemistry

### III. TEACHING

#### A. Undergraduate Study

4th semester

Analytical Chemistry I. (2-2 h)

Krupčík, Labuda, Polonský, Vrábel

Laboratory Practice AC I.

(0-4 h)

Valachovičová

5th semester

Analytical Chemistry II.

(2-2 h)

Bustin, Čakrt, Lehotay, Polonský

Laboratory Practice AC II.

(0-4 h)

Korgová

Testing and Quality Control

(1-1 h)

Čakrt

6th semester

Semestral Project

7th semester

Atomic Spectrometry

(2-0 h)

Beinrohr

Anal.Chem.of Complex Inorg. Mixtures

(2-0 h)

Oktavec

Anal.Chem. of Complex Org. and

Biological Mixtures

(2-0 h)

Brandšteterová

Lab.Practice I.

(0-10 h)

Matisová

Biosensors	(2-1 h)	Labuda
Computer evaluation of anal. measurement	(2-0 h)	Májek, Mocák
8th semester		
Electrochemistry and Electro-analytical Chemistry	(2-1 h)	Bustin
Techniques of Mixtures Separation	(2-2 h)	Matisová, Valigura
Analytical Separation of Compounds	(2-1 h)	Krupčík
Lab.Practice II	(0-6 h)	Matisová
Trace Analysis and Microanalysis Methods	(2-0 h)	Beinrohr, Čákr
9th semester		
Bioanalytical Chemistry	(2-1 h)	Labuda, Mocák
Identification of Chemical Substances	(2-1 h)	Lehotay, Liptaj
Lab.Practice V.	(0-10 h)	Matisová
Automatisation of Analytical Chemistry	(2-0 h)	Rievaj
Nuclear Analytical Chemistry	(2-0 h)	Tarapčík
Environmental Analytical Chemistry	(2-0 h)	Benická, Buzinkaiová
10th semester		
Laboratory of Diploma Work	(0-30 h)	
Selected Subjects		

## V.

### CURRENT RESEARCH PROJECTS

#### A. Development and Application of Direct Injection Assays for HPLC Analysis of Some Drugs and Toxic Compounds in Biological Samples ( Eva Brandšteterová)

The aim of the project is the development and application of new automated assays with the possibility of direct injection of biological samples into the HPLC system. New sorbents, especially with restricted access for macromolecules ( Restricted Access Materials- RAM ) and high retention and preconcentration ability for analyzed compounds are tested for the pre-separation step.

RAM precolumns with the recommended material have been integrated directly into the HPLC system what improves validation parameter values and minimizes the personal contact with biofluids. Direct sample injection of biological samples ( hemolyzed blood, plasma, serum, urine, homogenates of tissue, supernatants of cell cultures, extracts of plants and milk ) with the application of RAM materials has not been widely applied till now and the study of optimal extraction and retention conditions, interactions of analytes and matrix biopolymers with the sorbent enable to integrate the RAM extraction precolumn into the HPLC equipment.

The results obtained during the project research works:

- Some new assays have been developed for the direct achiral and chiral HPLC analysis of chosen drugs and their metabolites with the applications of various new sorbents in pre-separation columns integrated on-line into the HPLC system and results have been compared with techniques, commonly used in biological sample handling. Column-switching system was applied for the development of new procedures in drug monitoring in clinical material and the HPLC analysis of biological compounds in food and plant samples.
- RAM sorbents have been chosen with acceptable hydrophobic behaviour for the analyzed compounds and elution parameters have been determined with the aim to achieve the sufficient preconcentration of analytes in biological matrices.
- The results of HPLC and electromigration methods (CE) have been compared for chiral separation of some drugs and their metabolites in clinical samples and some new methods have also been developed for direct ITP analysis of the group of drugs in biological material and organic acids in food samples.

The study of interactions with the influence on selectivity of chiral drug separation has been realized, the possible steric influence, the effect of separated molecules caused by mobile and stationary phases have been studied and the separation mechanism for applied chromatographic system has been explained.

#### B. New Electroanalytical and Spectroscopic Systems for Ultra-trace and Speciation Analysis with Special Emphasis to Environmental and Clinical Problems. Optimization of analytical procedures (Dušan Bustin)

The aim of the project is the development of analytical methods for trace and ultratrace analysis of complex clinical and environmental samples. The results achieved during recent stage of research can be summarized as follows:

- Analytical methods for determination of Se and dithiocarbamates in environmental samples were developed and characterized metrologically. The methods apply Interdigitated Microelectrode Array in dual polarization mode.
- Metrological characterization and validation was accomplished for AAS determination of As and Se using electrochemical generation of corresponding hydrides.

- Analytical method for simultaneous determination of Zn, Cd, Pb and Cu using flow galvanostatic stripping coulometry was developed.
- A new method for determination of electroactive species using total electrolysis inside porous electrode was developed. The method was tested for determination of some metals (Fe, Cr) and non-metals (halogenides, oxygen, nitrates, organic species) in aquatic samples.
- A new method of determination of limit of detection was applied in different regions of trace analysis.
- Interfering signals in voltammetry were deconvoluted using their transformation by semidifferentiation.

C. Trace analysis of selected analytes in complex organic systems by combination of preconcentration techniques and capillary gas chromatography (Eva Matisová)

The project is oriented to the development of methods for the trace analysis of selected, particularly volatile and semivolatile compounds in complex organic systems - in environmental matrix (predominantly water) utilising preconcentration techniques in combination with capillary GC. A part of the project is devoted to the miniaturisation in analytical chemistry - to the development of microextraction methods for the sample preparation, large volume injection (small sample size necessary) in capillary GC. A part of the project is connected with the development of high speed GC and combination with preconcentration techniques for the analysis of semivolatiles polarity thermolabile compounds. High speed gas chromatography allows the shortening of the time of analysis have evaluated the present state of the theory of high speed capillary GC, influencing the speed of analysis and instrumentation which could be utilized for GC – conventional and ultra high speed GC utilising specially development Instrumentation. For the aims of trace analysis we have used high speed GC with own column injection. We have shown the necessity of the combination of conventional dimensions precolumn with the narrow bore analytical capillary column, which allows a sample introduction without the peaks broadening. The influence of experimental parameters, as column head pressure, injection volume, injection temperature of the temperature programme and temperature gradient on peaks focusing was searched.

#### D. CEEPUS Project PL-0110-00/01 (Ján Mocák)

The Project, planned for the schoolyear 2000/2001, concerns 5 cooperating Universities: (1) Faculty of Material Science and Ceramics, University of Mining and Metallurgy, Kraków, Poland, (2) Institute für Analytische Chemie, Karl-Franzens-Universität, Graz, Austria, (3) Faculty of Chemistry & Chemical Technology, University of Ljubljana, Slovenia, (4) Department of Analytical Chemistry, Slovak University of Technology, Bratislava, Slovak Republic, and Institute of Analytical Chemistry, Faculty of Chemical Technology, University of Pardubice, Czech Republic.

The collaboration is focussed on education and research in analytical chemistry, especially at the postgraduate and graduate level, mainly in the following areas: development and improvement of contemporary analytical methods and procedures, monitoring the environmental pollution, application of the quality systems and accreditation requirements to the research and routine analytical laboratories. The following key activities have been planned for the Project:

- 1) Mobility of the PhD and Master degree students to improve their educational level and language skills.
- 2) Mobility of the teaching staff to increase their teaching performance.
- 3) Utilization of unique or rarely available instruments and experience of their operation by the cooperating partners - the students as well as academic staff.
- 4) Preparation of joint scientific outputs.

E. Development of new analytical methods in environment and pharmaceutical drugs in biological systems (Drahomír Oktavec)

1. The aim of this Project is:

- a) to develop methods for the determination of trace and ultra trace amounts of chosen toxic elements and compounds in the air, soils and waste products of industrial factories which would also allow to monitor their transition into the food chain of mammals,
- b) on the base of chromatographic methods to model conditions in biological materials and develop methods both for the determination of pharmaceutical drugs and their degradation products in biological systems as well as for the separation of enantiomers of pharmacologically active compounds,
- c) to study crystal and molecular structure of biologically active compounds by X-ray structure methods, which results are obliged as qualitative criteria for drugs.

2. In the frame of the project the very good results were achieved in the field of the study of some drugs by HPLC and structural analysis. Also, the some pollutants in environmental were studied. The students were included in the study and so the project had the very good education efficiency (diploma and project works). Some results of the study were used into education process in the field of practical student training. Besides of diplom and project works 7 lectures were presented on the international symposia and local conferences.

F. The development of modern method for teaching analytical chemistry supported by PC (Pavol Tarapčík)

This project is directed to overcome drawbacks of traditional teaching method by applying relatively individual work methods in front of PC in the field of analytical chemistry. Chemical equilibria as applied in analytical chemistry represents for students relatively complex problem both in chemical and mathematical description. The last one is often crucial in the classroom work but represents only the tool, not the content analytical chemistry. The principal aim of the project is: by minimising time consuming calculation in classroom open new possibilities to recognise chemical principles of analytical methods.

The main goals of this project are:

- to make simulating software for various analytical methods, mainly in the area of chemical equilibria in analytical chemistry,
- to make teaching procedures supported by simulating software, combining work methods in whole group by traditional method and in small groups (two-three students) with PC.
- to make templates for solving typical problems of analytical chemistry.

We have prepared new teaching software supports based on spreadsheet „EXCEL“. These products include: software intended to assist teaching acid-base equilibria,

application software of chemical equilibria in analytical methods,

solved templates of typical analytical and equilibrium problems (on PC)

The textbook containing typical solutions of analytical problems was prepared as well.

## V. COOPERATION

### A. Cooperation in Slovakia

Department of Analytical Chemistry PrF UK Bratislava  
Faculty of Natural Sciences, Comenius University, Bratislava  
Faculty of Medicine, Comenius University, Bratislava  
Faculty of Pharmacy, Comenius University, Bratislava  
Food Research Institute, Bratislava  
Institute of Veterinary Hygiene and Ecology, Trnava  
National Institute of Oncology, Bratislava  
Slovak Academy of Sciences, Bratislava

### B. International Cooperation

Department of Analytical Chemistry, Palacky University, Czech Republic  
Department of Chemistry, Gilman Hall, Iowa State University, Ames, IA 50011-3111, USA  
Chiral separation of optical active compounds by GC and SFC  
Department of Organic Chemistry, Gent University, Gent, Belgium  
Chiral separation of optical active compounds by GC and SFC  
Department of Oncology, University of California, San Diego, U. S. A.  
Department of Pharmacology, McGill University, Montreal, Canada  
Faculty of Material Science and Ceramics, University of Mining and Metallurgy, Kraków, Poland  
Electrochemical trace analysis  
Advanced chemometric evaluation of analytical data  
Institute of Analytical Chemistry, University of Leipzig, Germany  
Electrochemical methods in atomic spectroscopy  
Institute of Pharmaceutical Chemistry, University of Muenster, Germany  
Institute of Pharmacy, University of Liege, Belgium  
National Research Institute of Health Science, Tokyo, Japan  
Organic Compounds in Aerosols  
Technical University Vienna, Institute of Analytical Chemistry, Vienna, Austria  
Utilization of Capillary GC in Combination with reconcentration Techniques for the Analysis

### C. Membership in Domestic Organizations and Societies

Editorial Board of the Slovak scientific journal Laboratory Diagnosis (J. Mocák)  
Slovak Chemical Society at Academy of Science, Group of Analytical Chemistry (J. Krupčík)  
Slovak Chemical Society, Chromatographic group (E. Brandšteterová)  
Slovak Chemical Society, Bratislava (J. Labuda)  
Slovak Research Technical Society (E. Brandšteterová)  
Slovak Society of Industrial Chemistry, Bratislava (J. Labuda, M. Bučková, M. Vaničková)  
Slovak Spectroscopic Society Bratislava (E. Beinrohr, A. Manová, J. Laštincová)

#### D. Membership in International Organisations and Societies

Advisory board member of the Fresenius Journal of Analytical Chemistry (E. Beinrohr)  
Federation of European Chemical Societies- delegate of the Slovak Chemical Society in the Division of Analytical Chemistry (J. Labuda)  
Gessellschaft Deutscher Chemiker, Frankfurt (E. Beinrohr)  
International Union Against Cancer, Switzerland (E. Brandšteterová)

#### E. Tempus Programme :

##### F. International Scientific Programmes :

1. Biosensors for Direct Monitoring of Environmental Pollutants in the Field, INCO-COPERNICUS PROJECT ERBIC 15CT960804, Labuda J., project manager, University of Athens, January 1997 – January 2001

2. SLOVAK – US UNIVERSITIES CO-OPERATION Project Title: Mechanistic study of chiral recognition in HPLC and HRGC, J. Krupčík

The main objective of the project is to study some mechanistic aspects of chiral recognition in the direct separation of enantiomers by HPLC and HRGC. The project consists of following parts:

- 1 An influence of structure and polarity differences in substituents bonded to the asymmetric carbon atom in enantiomers, and selectivity of a chiral selector in HPLC and HRGC shall be studied in detail. Modified  $\alpha$ -,  $\beta$ - and  $\gamma$ -cyclodextrins and macrocyclic antibiotics shall be used in gas and/or liquid chromatography as chiral selectors.
- 2 Thermodynamic data which characterize overall and enantioselective interactions of the enantiomers with chiral selectors shall be collected to gain more insight into the mechanistic aspects of enantioseparation on modified cyclodextrins.
- 3 A dependence of selectivity of a chiral column on the concentration of a chiral selector in polysiloxane solvent (a column coated with a mixed chiral phase and achiral phases) shall be compared with the overall selectivity of two columns coupled in series. In the column series, stationary phases in the individual chiral and achiral columns shall be identical with those used in column coated with the mixed chiral and polysiloxane phases.
- 4 Reasons responsible for the temperature dependence of retention order shall be studied by the GC separation of enantiomers on modified  $\alpha$ -,  $\beta$ - and  $\gamma$ -cyclodextrins.
- 5 For mechanistic studies of enantiomers separated by chiral HPLC on macrocyclic antibiotics indirect detection techniques shall be introduced.
- 6 Selectivity of two chiral columns coupled in series for the direct separation of enantiomers by HRGC and RP HPLC shall be tuned by the change of mobile phase flow rate in individual columns. Elaborated optimum separation system shall be used for two dimensional separation of optically active compounds in natural samples.

Slovak Principal Investigator: Prof. Ján Krupčík, PhD. DSc., Department of Analytical Chemistry, CHTF STU in Bratislava, Slovak Republic

Main American Investigator: Prof. Daniel W. Armstrong, Department of Chemistry, Gilman Hall, Iowa State University, Ames, IA 50011-3111, USA

3. NATO Project 621: Development of methods for determination biodegradation explosive pollutants. J. Lehotay, project manager.

The main aim of the project is the development of new analytical methods for ultratrace determination of some nitroaromatic in ground water and contaminated soil by a combination of a phase extraction and HPLC using diode array and electrode detection. In this year the determination of some nitroaromatic compounds in contaminated soil samples was developed. The determination limit (1 ppb) was achieved. The extraction method also included in the study.

#### G. Visitors from Abroad

Prof. H. J. Vander Linde Pretoria, South Africa, March 1999 (1 day)

Profesor Jose Antonio Garcia Dominguez Institute of Physical Chemistry Rocasolano v Madrid, Spain (2 days)

#### H. Visits of Staff Members and Postgraduate Students in Foreign Institutions

B. Balla Graz, Austria, July 2-7 2000 (4 days)

E. Beinrohr Bonn, Deutschland, conference, June 12-16 2000 (5 days)

E. Beinrohr Bologna, Poland, June 19-21 2000 (3 days)

E. Beinrohr Warsaw, Poland, conference, June 26-30 2000 (5 days)

E. Beinrohr Klivice, Poland, conference, July 9-13 2000 (5 days)

E. Beinrohr USA, conference, August 2-15 2000 (14 days)

E. Beinrohr Czech Republic, conference, August 30-31 2000 (3 days)  
 E. Beinrohr Czech Republic, symposium, September 12-14 2000 (3 days)  
 E. Beinrohr Deutschland, conference, 5-7 October 2000 (3 days)  
 E. Beinrohr Czech Republic, November 7-8 2000 (2 days)  
 E. Beinrohr Czech Republic, November 16 2000 (1 day)  
 E. Benická Italy, conference, June 5-10 2000 (6 days)  
 E. Brandšteterová Turkey, June 2000 2-16 (15 days)  
 E. Brandšteterová Czech Republic, conference, September 4-6 2000 (3 days)  
 M. Bučková Czech Republic, July 19-23 2000 (4 days)  
 A. Čaniová Czech Republic, conference, August 21-25 2000 (5 days)  
 J. Dzurov Czech Republic, conference, May 30-June 1 2000 (3 days)  
 A. Ferancová Poland, May - June 2000 (1 month)  
 A. Ferancová Czech Republic, conference, September 17-20 2000 (4 days)  
 A. Hercegová Czech Republic, conference, August 28-September 1 2000 (5 days)  
 K. Hroboňová Italy, conference, June 5-10 2000 (6 days)  
 K. Hroboňová Czech Republic, conference, September 4-6 2000 (3 days)  
 K. Hroboňová Czech Republic, conference, September 17-20 2000 (4 days)  
 K. Hroboňová Czech Republic, conference, October 19-21 2000 (3 days)  
 P. Korytár Wien, Austria, March 30 2000 (1 day)  
 P. Korytár Italy, conference, June 5-10 2000 (6 days)  
 P. Kotianová Wien, Austria, November 6 2000 (1 day)  
 P. Kotianová Wien, Austria, December 7-9 2000 (3 days)  
 J. Krupčík Wien, Austria, January 18 2000 (1 day)  
 J. Krupčík Deutschland, symposium, April 16-20 2000 (5 days)  
 J. Krupčík Italy, conference, June 5-10 2000 (6 days)  
 J. Krupčík Czech Republic, conference, September 4-6 2000 (3 days)  
 J. Krupčík Croatia, October 9-13 2000 (5 days)  
 P. Kubalec Deutschland, May 2000-April 2001 (12 months)  
 J. Labuda Greece, May 11-14 2000 (5 days)  
 J. Labuda Deutschland, June 10-16 2000 (6 days)  
 J. Labuda Poland, May 31-June 2 2000 (3 days)  
 J. Labuda Portugal, September 2-7 2000 (6 days)  
 J. Labuda Deutschland, September 19-November 19 2000 (2 months)  
 J. Lehotay Wien, Austria, January 18 2000 (1 day)  
 J. Lehotay Deutschland, symposium, April 16-20 2000 (5 days)  
 J. Lehotay Italy, conference, June 5-10 2000 (6 days)  
 J. Lehotay Czech Republic, conference, September 4-6 2000 (3 days)  
 J. Lehotay Czech Republic, conference, October 19-21 2000 (3 days)  
 P. Májek Italy, conference, June 5-10 2000 (6 days)  
 E. Matisová Wien, Austria, January 18-19 2000 (2 days)  
 E. Matisová Wien, Austria, March 30 2000 (1 day)  
 E. Matisová Greece, May 10-17 2000 (8 days)  
 E. Matisová Italy, conference, June 5-10 2000 (6 days)  
 E. Matisová Wien, Austria, November 6 2000 (1 day)  
 J. Mocák Pardubice, Czech Republic 2-3 May 2000 (2 days)  
 J. Mocák Graz, Austria, July 2-5 2000 (4 days)  
 J. Mocák Czech Republic, November 21-24 2000 (4 days)  
 P. Oswald Belgium, April-June 2000 (1 month)  
 P. Oswald Italy, conference, June 5-10 2000 (6 days)  
 I. Špánik Italy, conference, June 5-10 2000 (6 days)  
 I. Špánik Deutschland, July 10-August 8 2000 (1 month)

## VI. THESES AND DISSERTATIONS

A. Graduate Theses (MS Degree) for state examinations after five years of study in Analytical Chemistry (Supervisors are written in brackets)

Árendáriková S.: In - electrode coulometric titrations (E. Beinrohr)

Bajdichová M.: Calculation of enantiomerization energy barrier of thermal labile optical active compound separated by gas chromatography on chiral phases (J. Krupčík)

Bindzárová I.: The determination of sorbic acid in food products (T. Buzinkaiová)

Ďungelová J.: Separations of some enantiomers of phenylcarbanic derivates by HPLC (J. Lehotay)

- Fedorčáková A.: Speciation of phosphate salts in aqueous solutions (P. Tarapčík)
- Fuknová M.: Analysis with DNA biosensor (J. Labuda)
- Heilerová L.: Ninhydrin as a luminescence reagent (M. Čakrt)
- Husáková G.: Electrochemical generation of hydrides for atomic spectroscopy (A. Manová)
- Javorová S.: The study of Possibilities of RAM sorbents in HPLC of clinical sorbents (E. Brandšteterová)
- Kotianová P.: Capillary gas chromatography and its utilisation in the analysis of mixtures of organic compounds (E. Matisová)
- Mičič S.: Creation and adaption of Chemometrically and metrologically oriented Software (J. Mocák)
- Nyúlóvá K.: Study of Spectral Properties and Separation of some Toxic Metal Ditiocarbamates (D. Oktavec)
- Orošová K.: Isotachophoretic study of some drugs. (J. Sádecká)
- Podhradská I.: HPLC analysis of phenolic acids in *Melissa officinalis* (E. Brandšteterová)
- Rosincová D.: Determination of drugs using electrode modified with  $\beta$ -cyclodextrin (E. Korgová)
- Vývleková Z.: Application of voltammetric microelectrodes in ultratrace analysis (M. Rievaj)
- Zajíčková Z.: Use of gas chromatography and derivatization in analysis of selected compounds from environmental matrices (E. Benická)

#### B. Dissertations (PhD.):

Špánik I.: The study of mechanistic aspects of chiral separation in capillary gas chromatography on cyclodextrin stationary phases (J. Krupčík)

#### VII. Publications

##### A. Journals (\* registered in Current Contents)

- [1]\* Argalášová - Šutovská K., Lux A., Bovanová L., Čaniova A., Brandšteterová E.: Comparison of Peroxisomicine A1 content in vegetative organs of *Karwinskia Humboldtiana* and *Karwinskia Parvifolia*. *Plant Production* 46, 477 - 480 (2000)
- [2]\* Bobrowski A., Kasprzyk G., Mocák J.: Theoretical and Experimental Resolution of Semi-derivative Linear Scan Voltammetry. *Collect. Czech. Chem. Commun.* 65, 979 - 994 (2000)
- [3]\* Bovanová L., Brandšteterová E.: Direct analysis of food samples by HPLC. *J. Chromatogr. A* 880, 149 - 168 (2000)
- [4]\* Buzinkaiová T., Polonský J.: Determination of four selective reuptake inhibitors by capillary isotachopheresis. *Electrophoresis* 21, 2839 - 2841 (2000)
- [5] Buzinkaiová T., Medveďová M.: Možnosti stanovenia antidepresív tretej generácie. The possibilities for the determination of 3. generation antidepressants (in Slovak). *Farmaceutický obzor* 9 - 10, 227 - 231 (2000)
- [6] Buzinkaiová T.: Dioxíny a životné prostredie. Dioxins and environment (in Slovak). *Chémia* 14, 3 - 7 (2000)
- [7]\* Čakrt M., Buzinkaiová T., Polonský J., Kořínková V.: Spectrofluorimetric and isotachophoretic determination of maprotiline in human blood serum. *Electrophoresis* 21 (14) 2834 - 2838 (2000)
- [8]\* Fanali S., Desiderio C., Ölvecká E., Kaniansky D., Vojtek M., Ferancová A.: Separation of Enantiomers by On-Line Capillary Isotachopheresis-Capillary Zone Electrophoresis. *J. High Resol. Chromatogr.* 23, (9) 531 - 538 (2000)
- [9]\* Fargašová A., Beinrohr E.: Cadmium-metal interactions determined through root elongation and metal accumulation in *Sinapis Alba*. *Chem. Listy* 94, 833 - 834 (2000)
- [10]\* Ferancová A., Korgová E., Mikó R., Labuda J.: Determination of tricyclic antidepressants using carbon paste electrode modified with beta-cyclodextrin. *J. Electroanal. Chem.* 492, 74 - 77 (2000)
- [11]\* Hercegová A., Sádecká J., Polonský J.: Determination of some antirheumatics by capillary isotachopheresis. *Electrophoresis* 21, 2842 - 2847 (2000)
- [12]\* Hroboňová K., Lehotay J., Čižmárik J., Armstrong D. W.: HPLC Separation of Enantiomers of Alkylsubstituted Esters of Phenylcarbamic Acid. *J. High Resol. Chromatogr.*, 23, 288 (2000)
- [13]\* Hroboňová K., Lehotay J., Čižmárik J.: HPLC Enantioselective Separation of Alkoxy-substituted Esters of Phenylcarbamic Acid on Teicoplanin stationary phase. *Chemické listy*, 94, 964 (2000)
- [14] Hrouzek J., Krupčík J., Čeppan M., Hatrík S., Leclercq P. A.: A Novel Method for Peak Number Estimation in Chromatographic Peak Clusters. *Chem. Papers* 54 (5) 314 - 318, (2000)
- [15\*] Jurica L., Manová A., Dzurov J., Beinrohr E., Broekaert J.A.C.: Calibrationless flow-through stripping coulometric determination of arsenic (III) and total arsenic in contaminated water samples after microwave assisted reduction of arsenic (V). *Fresenius J. Anal. Chem.* 366, 260 - 266 (2000)
- [16]\* Jurica L., Beinrohr E.: Stanovenie stopových koncentrácií arzenu elektrochemickou rozpúšťacou analýzou. Determination of trace analysis by electrochemical stripping analysis (in Slovak). *Chem. Listy* 94, 159 - 167 (2000)
- [17] Kohúteková V., Hrabčáková L., Beinrohr E.: Význam pasivácie pocínovaných obalových plechov, zloženie pasivačnej vrstvy a možnosti jej hodnotenia. The importance of passivation of steel sheets, the

composition of the passivation layer an ways of this evaluation (in Slovak). *Acta Mechanica Slovaca* 3, 33 - 36 (1999)

[18]\* Korytár P., Matisová E., Leflerová H., Slobodník J.: Large Volume Injection in Fast Gas Chromatography with On-Column Injector. *HRC - J. High Resol. Chromatogr.*, 23, 149 - 155 (2000)

[19]\* Kotianová P., Matisová E.: Mikroextrakcia kvapalina-kvapalina a jej využitie pri stopovej analýze organických látok vo vodnej matrici. Microextraction liquid-liquid and its utilisation in trace analysis of organic compounds in water matrix (in Slovak). *Chemické Listy* 94, 220 - 225 (2000)

[20]\* Kozáková E., Bodor R., Jursa J., Beinrohr E.: Flow - through coulometric determination of mercury in soils and soil extracts. *Chem. Papers* 54, 144 - 147 (2000)

[21]\* Krupčík J., Špánik I., Oswald P., Májek P., Skačáni I., Sandra P.: On the Calculation of Gibbs Energy Corresponding to Enantioselective Interactions at a Direct HRGC Separation of Enantiomers. *Chirality* 12, 130 - 138 (2000)

[22]\* Labuda J., Vaničková M., Bučková M., Korgová E.: Development in analysis with chemically modified electrodes and biosensors. *Chem. Papers* 54 (2), 95 - 103 (2000)

[23]\* Labuda J., Bučková M.: Selectivity of the voltammetric determination at an ion-exchanger modified electrode. *Electrochemistry Communications* 2, 322 - 324 (2000)

[24]\* Labuda J., Bučková M., Jantová S., Štěpánek I., Surugiu I., Danielsson B., Mascini M.: Modified Screen-Printed Electrodes for the Investigation of Non-electroactive Quinazoline Derivatives Interaction with DNA. *Fres. J. Anal. Chem.* 367 (4), 364 - 368 (2000)

[25]\* Masarovičová E., Welschen R., Lux a., Lambers H., Argalášová K., Brandšteterová E., Čaniová A.: Photosynthesis, biomass and peroxisomicine A1 production of *Karwinskia* species in response to nitrogen supply. *Physiol. Plant.* 108, 300 - 306 (2000)

[26] Matisová E., Medveďová M., Vraniaková J.: Vplyv fyzikálno-chemických faktorov na extrakčnú výťažnosť OSPME environmentálnych polutantov. Influence of physico-chemical factors on SPME extraction recovery of environmental pollutants (in Slovak). *Ropa a Uhlie* 41 (4), 18 - 22 (1999)

[27] Medveďová M., Vraniaková J., Matisová E.: Vplyv fyzikálno-chemických parametrov na extrakčnú výťažnosť SPME environmentálnych polutantov. II. Semiprchavé organické látky. Influence of physico-chemical factors on SPME extraction recovery of environmental pollutants. II. Semivolatile organic compounds (in Slovak). *Ropa a Uhlie* 42 (1), 42 - 50 (2000)

[28] Mocák J., Balla B.: Nové možnosti multivariačnej analýzy a jej perspektívy v laboratórnej medicíne. New Potentiality of Multivariate Analysis and its Perspectives in Laboratory Medicine (in Slovak). *Labor. diagnostika* 5, 23 - 24 (2000)

[29] Peťka J., Balla B., Farkaš P., Mocák J., Kováč M.: Klasifikácia vybraných slovenských odrodových vín. Classification of Selected Slovak Variety Wines (in Slovak). *Kvasný průmysl* 46, 244 - 247 (2000)

[30]\* Sádecká J., Polonský J.: Electrophoretic methods in the analysis of beverages. *Journal of Chromatography A* 880, 243 - 279 (2000)

[31]\* Sádecká J., Hercegová A., Polonský J.: Determination of flurbiprofen in human serum by capillary isotachopheresis. *Pharmazie* 55, 859 - 860 (2000)

[32]\* Sivý J., Vrábel V., Renčová M.: Crystal structure of 1-[2-Phenylcarbamoyloxy)ethyl]piperidinium Chloride. *Chem. Papers* 54 (1), 19 - 23 (2000)

[33]\* Špánik I., Krupčík J.: Využitie cyklodextrínov ako stacionárnych fáz na separáciu enantiomérov kapilárnou plynovou chromatografiou. *Chem. Listy* 94, 10 - 14 (2000)

[34]\* Tarapčík P., Labuda J., Fourest B., Pätoprstý V.: Measurement uncertainty distributions and uncertainty propagation by the simulating approach. *Accred Qual Assur* 5: 8 (2000)

[35]\* Tomčík P., Bustín D.: Interdigitated Array Diffusion Layer Titration of Dithiocarbamates with Electrogenerated Hypobromite. *Coll. Czech. Chem. Commun* 65, 1029 - 1034 (2000)

[36]\* Vaničková M., Bučková M., Labuda J.: Voltammetric determination of azepine and phenothiazine drugs at DNA biosensors. *Chem. Anal. (Warsaw)*, 45, 125 - 133 (2000)

[37]\* Vaničková M., Labuda J., Bučková M., Surugiu I., Mecklenburg M., Danielsson B.: Investigation of catechin and acridine derivatives at voltammetric and fluorimetric DNA-based sensors. *Collect. Czech. Chem. Commun.* 65 (6), 1055 - 1066 (2000)

#### B. Conferences (\* international conferences)

[1]\* Balla B., Mocák J.: Multivariate Analysis of Selected Foodstuff and Biological Materials. In: *YISAC 2000 - Book of Abstracts*, Austrian Sci. & Res. Ln., Graz, Austria, July 2. - 5. 2000, p. 39

[2]\* Beinrohr E.: Flow - through coulometry: A useful tool for the determination of metals and some non-metals. *Proceedings of the conference VI Polish conference on analytical chemistry*, Gliwice, Poland, Komitet Chemii Analitycznej PAN, Warszawa, July 9. - 14. 2000, p. 34 - 35, Band II



- [3]\* Beinrohr E.: Automatizované elektroanalytické systémy, Automatised electroanalytical systems (in Slovak). ICP and AAS spektrometry, electroanalytical methods, Žermanecká priehrada, Czech Republic, August 22. – 24. 2000
- [4] Beinrohr E., Manová A., Dzurov J.: Monitorovanie ťažkých kovov. Monitoring of heavy metals ( in Slovak). XXIX Conference Synthesis and Analysis of Drugs , Bratislava, Slovak Republic, September 11. - 13. 2000
- [5]\* Beinrohr E.: Flow-through coulometry in the determination of trace, minor and major components. Book of abstracts 8<sup>th</sup> International conference on flow analysis, University of Warsaw, Poland, June 25. – 29. 2000, p. 48 - 48
- [6]\* Beinrohr E.: Coated porous carbon electrodes in electroanalytical chemistry. Book of abstracts J. Heyrovsky memorial symposium, J. Heyrovský Institute of Physical Chemistry Praha, Czech Republic, August 30. – September 1., 2000, p. 30 – 30
- [7]\* Beinrohr E., Manová A., Dzurov J.: New coulometric methods for food and beverage analysis. Book of abstracts Modern analytical methods for food and beverage authentication, Lednice, Czech Republic, Eurofins scientific SA, Nantes, August 31. – September 2. 2000, p. 30 - 30
- [8]\* Beinrohr E.: Unattended monitoring of heavy metals in waters. Book of abstracts Fifth international symposium and exhibition on environmental contamination in Central and eastern Europe, Prag, Czech Republic, Florida State University, September 12. - 14. 2000, p. 197 – 197
- [9]\* Beinrohr E., Broekaert J. A. C.: Flow - through coulometry in process and environmental monitoring. Book of abstracts 3<sup>rd</sup> International colloquium on process related environmental analytical chemistry, University Leipzig, Germany, October 2000, p. 20 - 20
- [10]\* Beinrohr E.: In - electrode coulometric titrations: Determination of non-metals. Book of abstracts ESEAC 2000, Bonn, Germany, H. Emons, P. Ostapczuk (Eds), June 11. – 15. 2000, Schriften des Forschungszentrums Jülich, Volume 22, p. OC 22 - 22
- [11] Beinrohr E. : Využitie elektrochemických metód v stopovej analýze a spektroskopii. The use of electrochemical methods in trace analysis and spectroscopy (in Slovak). Proceedings Present state and perspectives of analytical chemistry in practice, SSPCH, branch CHTF STU Bratislava, Slovakia, September 18. – 21. 2000, pp. 35 - 35
- [12]\* Beinrohr E., Dzurov J.: Stanovenie Fe (II), Fe (III) a celkového železa vnútroelektrodovou coulometrickou titráciou. Determination of Fe(II) and Fe(III) by in-electrode coulometric titration ( in Slovak). Proceedings Metallurgical Analytical Chemistry 2000, Jasná, Slovakia, 2-theta, Český Těšín, April 10. - 14. 2000, pp. 74 - 78
- [13]\* Beinrohr E., Dzurov J.: Titrácie trochu inak. Unusual titrations (in Slovak). Proceedings Microelementy 99, Řež u Prahy, Czech Republic, 2 THETA Český Těšín 2000, November 16. - 18. 1999, pp. 160 - 162
- [14]\* Beinrohr E., Dzurov J.: Zaistenie strávnosti analýz v bezkalibračnom móde prietokového elektrochemického analyzátoru. Accuracy assurance in the calibrationless flow-through coulometry (in Slovak). Proceedings Assurance of the quality of analytical results, Komorní Lhotka, Czech Republic, 2 THETA Český Těšín, March 28. - 30. 2000, pp. 160 - 163
- [15]\* Beinrohr E., Dzurov J.: Porézne elektródy v analytickej chémii. Porous electrodes in analytical Chemistry (in Slovak). Proceedings Inorganic analysis in the environment, Komorní Lhotka, Czech Republic, 2 THETA Český Těšín 1999, September 20. – 23. 2000, pp. 91 - 97
- [16] Beinrohr E., Dzurov J.: Stanovenie ťažkých kovov vo vodách a sedimentoch metódou prietokovej coulometrie. Proceedings Hydrochemistry 2000, VÚVH Bratislava, Slovakia, May 24. – 25. 2000, pp. 182 - 188
- [17]\* Beinrohr E.: Automatic monitoring of heavy metals in waters. In.: International Conference on Heavy Metals in the Environment (J. Nriagu, Editor), Contribution No. 1371. University of Michigan, England, School of Public Health, Ann Arbor, MI, June 6. – 10. 2000, 4 p.
- [18] Bovanová L., Blahová E., Brandšteterová E.: Využitie systémov s prepínaním kolón v analýze potravinových vzoriek. The use of column-switching system in the analysis of food samples (in Slovak). Conference Progress in Chromatography and Electrophoresis 2000, Pardubice, Czech Republic, September 5. - 6. 2000, p. 68 – 69
- [19]\* Bovanová L., Blahová E., Brandšteterová E.: Use of restricted access media in HPLC analysis of food samples. 3<sup>rd</sup> Mediterranean Basin Conference on Analytical Chemistry, Antalya, Turkey, Book of Abstracts, June 4. - 9. 2000, p. 214
- [20] Brandšteterová E., Kubalec P., Bovanová L., Čaniová A.: Súčasný stav a trendy v úprave biologických vzoriek pred HPLC analýzou. State and trends in the sample preparation of biological samples before HPLC analysis (in Slovak). Progress in chromatography and electrophoresis 2000, Pardubice, Czech Republic, September 5. - 6. 2000, p. 13 – 14

- [21] Brandšteterová E., Čaniová A.: Výber stacionárnej fázy v HPLC separácii. The choice of stationary phase in HPLC separation (in Slovak). Summer School of HPLC, Bratislava, Slovak Republic, June 20. - 23. 2000, p. 5 - 17
- [22] Brandšteterová E., Čaniová A.: Prehľad nových HPLC kolón. New HPLC columns (in Slovak). Summer school of HPLC, Bratislava, Slovak Republic, June 20. - 23. 2000, p. 18 - 29
- [23] Brandšteterová E.: HPLC v analýze biologických vzoriek. HPLC in analysis of biological samples (in Slovak). Summer School of HPLC, Bratislava, Slovak Republic, June 20. - 23. 2000, p. 138 - 146
- [24] Brandšteterová E.: Disperzia matrice vzorky na tuhej fáze. Matrix Solid Phase Dispersion (in Slovak). Summer School of HPLC, Bratislava, Slovak Republic, June 20. - 23. 2000, p. 152 - 155
- [25] Brandšteterová E., Bovanová L.: Systém s prepínaním kolón. Column Switching System (in Slovak). Summer School of HPLC, Bratislava, Slovak Republic, June 20. - 23. 2000, p. 162 - 173
- [26] Brandšteterová E., Bovanová L., Kubalec P., Čaniová A.: Priama HPLC analýza liečiv a ich metabolitov. Direct HPLC analysis of drugs and their metabolites. XXIX Conference Synthesis and Analysis of Drugs, Bratislava, Slovak Republic, September 11. - 13. 2000, p. 2 - 3
- [27]\* Brandšteterová E., Bovanová L., Kubalec P., Čaniová A.: Direct HPLC analysis of biological samples. 3<sup>rd</sup> Mediterranean Basin Conference on Analytical Chemistry, Antalya, Turkey, June 4. - 9. 2000, Book of Abstracts, p. 90
- [28]\* Bučková M., Labuda J., Vaničková M.: DNA Biosensors for Environmental and Clinical Analysis. In: Book of Abstracts, DNA Structure and Interactions, Their Biological Roles and implications in Biomedicine and Biotechnologies, Brno, Czech Republic, July 19. - 23. 2000, p. L 4 - 8
- [29]\* Bučková M., Labuda J., Vaničková M.: DNA Biosensors for Environmental and Clinical Analysis. In: Journal of Biomolecular Structure and Dynamics, Vol. 17, Issue 6, Part 2, 2000
- [30]\* Bučková M., Labuda J., Vaničková M., Fuknová M.: DNA biosensors for voltammetric determination of natural and synthetic antioxidants and pollutants directed to food analysis. In: Scientific programme and book of abstracts INCO-COPERNICUS IC15-CT96-0804 Biosensors for Direct Monitoring of Environmental Pollutants in the Field, 6th Workshop: Scale - up Production and Commercialization, Lund, Sweden, September 22. - 24. 2000
- [31] Bučková M., Labuda J.: Stanovenie špeciácie kovu založené na kinetike jeho intreakcie s elektrochemickým senzorom. Determination of Metal Speciation based on a Kinetic of its Interaction with Electrochemical Sensor (in Slovak). Conference Present state and perspectives of analytical chemistry in praxis, Department of analytical chemistry, Faculty of chemical technology, STU, Bratislava, Slovak Republic, September 18. - 21. 2000, p. 95
- [32] Buzinkaiová T., Polonský J., Skačáni I.: ITP analýza kyseliny sorbovej vo vybraných potravinárskych výrobkoch. ITP analysis of sorbic acid in the chosen food products (in Slovak). Conference Present state and perspectives of analytical chemistry in praxis, Department of analytical chemistry, Faculty of chemical technology, STU, Bratislava, Slovak Republic, September 18. - 21. 2000, p. 110 - 111
- [33]\* Čakrt M., Hercegová A., Leško J., Polonský J., Sádecká J., Skačáni I.: Isotachophoretic determination of naproxen in the presence of its metabolite in human serum. In: Book of Abstracts of the 12th International Symposium on Capillary Electroseparation Techniques, ITP 2000, Bratislava - Vienna, Slovakia, Austria, September 10. - 13. 2000, A6
- [34] Čakrt M.: Zabezpečovanie kvality v analytických laboratóriách. Quality Assurance for Analytical Laboratories (in Slovak). VIII. Conference State of Arts and Perspectives of Analytical Chemistry in Praxis, Bratislava, Slovak Republic, September 18. - 21. 2000, p. 17 - 20
- [35] Čakrt M., Beinrohr E.: Nové elektrochemické vyšetrovacie metódy. Newer Electrochemical Investigation Methods (in Slovak). Book of abstract Chemické analýzy pri zabezpečovaní ochrany zdravia obyvateľstva, Donovaly, Slovakia, October 4. - 5. 2000, p. 8
- [36]\* Čakrt M., Hercegová A., Leško J., Polonský J., Sádecká J., Skačáni I.: Isotachophoretic determination of naproxen in the presence of its metabolite. ITP 2000, 12<sup>th</sup> International Symposium on Capillary Electroseparation Techniques, Bratislava - Vienna, Slovakia, Austria, September 10. - 13. 2000
- [37] Čaniová A., Podhradská I., Brandšteterová E.: HPLC stanovenie fenolických kyselín v Medovke lekárskej. HPLC determination of phenolic acids in *Melissa Officinalis* (in Slovak). Progress in chromatography and electrophoresis 2000, Pardubice, Czech Republic, September 5. - 6. 2000, p. 70 - 71
- [38]\* Čaniová A., Brandšteterová E., Podhradská I.: Stanovenie obsahu fenolických kyselín v Medovke lekárskej metódou HPLC. Determination of phenolic acids in *Melissa Officinalis* (in Slovak). VIII. Conference State of Arts and Perspectives of Analytical Chemistry in Praxis, Bratislava, Slovak Republic, p. 103 - 104
- [39] Čaniová A., Brandšteterová E., Argalášová K., Lux A.: HPLC stanovenie Peroxizomicínu A<sub>1</sub> v in vivo a in vitro kultúrach rastlín rodu *Karwinskia*. Determination of Peroxisomicine A<sub>1</sub> in vivo and in vitro cultures of plants *Karwinskia* (in Slovak). XXIX. Conference Synthesis and Analysis of Drugs, Bratislava, Slovak Republic, September 11. - 13. 2000, p. 40

- [40]\* Ferancová A., Korgová E., Labuda J., Kutner W.: Stanovenie tricyklických antidepresív elektródou modifikovanou cyklodextrínovým polymérnym filmom. Determination of tricyclic antidepressive drugs using electrode modified with polymer cyclodextrin films (in Slovak). 52. sjezd chemických společností, České Budějovice, Czech Republic, In: Chemické listy, 94 (9) Supplement, September 17. - 20.2000, p. 960
- [41] Hercegová A., Polonský J.: ITP determination of metoprolol and its metabolites in biological fluids. In: Book of Abstracts Advances in Chromatography and Electrophoresis, Pardubice, Czech Republic, September 5. - 6. 2000, p. 62 - 63
- [42] Hercegová A., Čákr M., Polonský J., Sádecká J.: Izotachoforetická analýza farmaceutických prípravkov. Isotachophoretic analysis of pharmaceutical preparations (in Slovak). 8th Conference Present State and Perspectives of Analytical Chemistry in Practice, Bratislava, Slovak Republic, September 18. - 21. 2000, p. 108 - 109
- [43]\* Hevesi J., Krupčík J., Audouze K., Chretien J. R.: Factor analysis of the Chromatographic information content in capillary gas chromatography. Symposium on Chemometrics, Paris, France, December 6. - 7. 2000
- [44]\* Hroboňová K., Lehotay J., Čižmárik J., Armstrong D. W.: HPLC Separation of Enantiomers of Alkylsubstituted Esters of Phenylcarbamic Acid. First International Symposium on Advances in Chromatographic and Electrophoretic Separations (ACES), Bayreuth, Germany, April 2000, Abstract P 23
- [45]\* Hroboňová K., Benická E., Lehotay J., Krupčík J.: On the direct enantiomeric separation of some amino acids derivatives by HRCG and HPLC. 23<sup>th</sup>. International symposium on capillary chromatography, Riva del Garda, Italy, June 5. - 10. 2000, Proc. M. 367, p. 1 - 6
- [46] Hroboňová K., Lehotay J.: Separácia enantiomérov alkylaminoderivátov aryloxypropanolu metódou vysokoúčinnnej kvapalinovej chromatografie. VIII. sjezd České farmaceutické společnosti a XVI. lékárnické dny, Hradec Králové, Czech Republic, Abstract of lectures and post, October 2000, p. 3 - 4
- [47] Hroboňová K., Lehotay J.: HPLC analýza nitroaromatických látok vo vzorkách pôd. HPLC analysis of nitroaromatic compounds in soil samples (in Slovak). V8th Conference Present State and Perspectives of Analytical Chemistry in Practice, Bratislava, Slovak Republic, September 18. - 21. 2000, p. 132
- [48] Hroboňová K., Lehotay J., Čižmáriková R.: HPLC separácia enantiomérov alkylaminoderivátov aryloxypropanolu použitím CSF na báze makrocyclických antibiotík. HPLC separation of enantiomers of aryloxypropanol alkylaminoderivates using CSF on the base of macrocyclic (in Slovak). XXIX. Conferency Synthesis and analysis of drugs, Bratislava, Slovakia, September 2000, Abstract p. 50 - 51
- [49] Hroboňová K., Lehotay J., Ďungelová J., Čižmárik J.: Chromatographic separation of alkoxy-substituted esters of phenylcarbamic acid on vancomycin-based stationary phase. Book of Abstracts Advances in Chromatography and Electrophoresis, Pardubice, Czech Republic, September 5. - 6. 2000, p. P 48
- [50]\* Hroboňová K., Lehotay J., Špánik I., Krupčík J.: Determination of some emission pollutants by HRGC and HPLC. 23<sup>rd</sup> International Symposium on Capillary Chromatography, Riva del Garda, Italy, June 5. - 10. 2000
- [51]\* Hroboňová K., Lehotay J., Čižmárik J.: HPLC Enantioselective Separation of Alkoxy-substituted Esters of Phenylcarbamic Acid on Teicoplanin stationary phase, 52. sjezd chemických společností, České Budejovice, Czech Republic, June 2000, Chemické listy 94, 964, 2000
- [52]\* Korgová E., Ferancová A., Labuda J.: Využitie cyklodextrínom modifikovaných screen-printed elektród na stanovenie liečiv, Utilization of screen-printed electrodes modified with cyclodextrin for determination of drugs (in Slovak). Conference Present state and perspectives of analytical chemistry in praxis, Department of analytical chemistry, Faculty of chemical technology, STU, Bratislava, Slovak Republic, September 18. - 21. 2000, P 3, p. 96 - 97
- [53] Korytár P., Matisová E., Slobodník J.: Introduction of Conventional Sample Volumes in a Fast Gas Chromatography; Papers edited on CD by Sandra P. and Racstraw A.J. In: 23<sup>rd</sup> International Symposium on Capillary Chromatography, Riva del Garda, Italy, June 5. - 10., 2000
- [54] Korytár P.: Rýchla plynová chromatografia. High speed gas chromatography (in Slovak), High speed gas chromatography and Preconcentration techniques, Millennium school, Department of analytical chemistry, Faculty of chemical technology, STU, Bratislava, Slovak Republic, May 30. - 2. June 2000, p. 7 - 26
- [55] Kotianová P., Matisová E.: Mikroextrakcia kvapalina-kvapalina a jej využitie pri stopovej analýze organických látok vo vodnej matrici. Microextraction liquid-liquid and its utilisation in trace analysis of organic compounds in water matrix (in Slovak). High speed gas chromatography and Preconcentration techniques, Millennium school, Department of analytical chemistry, Faculty of chemical technology, STU, Bratislava, Slovak Republic, May 30. - 2. June 2000, p. 41 - 51
- [56]\* Krupčík J., Oswald P., Špánik I., Májek P., Bajdichová P., Sandra P., Armstrong D.W.: On the use of a peak deconvolution method for computer assisted determination of energy barrier to enantiomerization in dynamic gas chromatography. 23<sup>rd</sup> International Symposium on Capillary Chromatography, Riva del Garda, Italy, June 5. - 10. 2000

- [57]\* Krupčík J., Oswald P., Benická E., Oktavec D., Skačáni I., Daučík P., Sandra P.: Determination of High Boiling Petroleum Hydrocarbons in Environmental Samples. *J. High Res.Chrom.* 23, 2000, 286
- [58]\* Krupčík J., Oswald P., Benická E., Oktavec D., Skačáni I., Daučík P., Sandra P.: Problémy so stanovením vyššie vriacich ropných uhľovodíkov v životnom prostredí. *Book of Abstracts Advances in Chromatography and Electrophoresis 2000*, Univerzita Pardubice Czech Republic, L 16, 2 p.
- [59] Krupčík J.: Reprodukovateľnosť merania elučných časov v plynovej chromatografii. *Reproducibility of retention times measurement in gas chromatography (in Slovak)*. *Proceedings of VII Conference State of art and perspectives of analytical chemistry in practice*, CHTF STU in Bratislava, Slovakia, 2000, p. 69 – 72
- [60] Krupčík J.: Reprodukovateľnosť merania elučných časov v plynovej chromatografii. *Reproducibility of retention times measurement in gas chromatography (in Slovak)*. *Scientific seminary of the Pragolab Company*, Poppy Hotel, Piešťany, Slovakia, September 27. – 29. 2000
- [61]\* Krupčík J., Oswald P., Špánik I., Májek P., Skačáni I., Sandra P., Armstrong D. W.: On the use of a peak deconvolution procedure for the determination of energy barrier to enantiomerization in dynamic chromatography. *Proceedings of the 23 rd International Symposium on capillary Chromatography*, Riva del Garda, Italy, Edited by P. Sandra and A. J. Rackstraw, I. O. P. M. S. Kortrijk, Belgium, June 5. – 10. 2000, A 20, 9 p.
- [62]\* Krupčík J., Oswald P., Benická E., Oktavec D., Skačáni I., Daučík P., Sandra P.: Determination of Petroleum Hydrocarbons in Environmental Samples. *Books of Abstracts of the 6<sup>th</sup> International Symposium New Achievements in Chromatography*, Plitvice Lakes, Croatia, Croatian Society of Chemical Engineers, Section of Chromatography, October 11. – 13. 2000, p. 59 - 64
- [63]\* Krupčík J., Oswald P., Benická E., Oktavec D., Skačáni I., Daučík P., Sandra P.: Determination of High Boiling Petroleum Hydrocarbons in Environmental Samples. *Proceedings of the First International Symposium on Advances in Chromatographic and Electrophoretic Separations University Bayreuth, Germany*, April 16. – 18. 2000, P 20, 2 p.
- [64] Kubalec P.: Extrakcia na tuhej fáze. *Solid Phase Extraction (in Slovak)*. *Summer School of HPLC*, Bratislava, Slovak Republic, June 20. - 23. 2000, p. 128 - 137
- [65] Kubalec P.: Biologické vzorky a ich predseparačná úprava. *Biological samples and their preseparation (in Slovak)*. *Summer School of HPLC*, Bratislava, Slovak Republic, June 20. - 23. 2000, p. 147 - 151
- [66] Kubalec P.: Restricted Access Materials. *Summer School of HPLC*, Bratislava, Slovak Republic, June 20. - 23. 2000, p. 156 - 161
- [67] Kubalec P.: Validácia analytickej metódy. *Validation of analytical method (in Slovak)*. *Summer School of HPLC*, Bratislava, Slovak Republic, June 20. - 23. 2000, p. 209 - 222
- [68]\* Kubalec P., Brandšteterová E.: Therapeutic drug monitoring using LC-column switching and restricted access precolumn packings. *5. Internationales LiChrospher ADS Anwendertreffen*, Munich, Germany, September 22. 2000, p. 5
- [69] Kubalec P., Brandšteterová E.: Predseparačné úpravy biologických vzoriek v HPLC. *Preseparation of biological samples in HPLC.VIII. Conference State of Arts and Perspectives of Analytical Chemistry in Praxis*, Bratislava, Slovak Republic, September 18. - 21. 2000, p. 60 - 61
- [70]\* Labuda J., Bučková M., Vaničková M., Ferancová A. : Chemically Modified Electrodes with DNA and Cyclodextrin. In: *Book of Abstracts, ESEAC 2000, 8th Internatl. Conference on Electroanalysis*, Bonn, Germany. *Electroanalysis (H. Emons and P. Ostapczuk, Eds.)*, Schriften des Forschungszentrums Jülich, Reihe Umwelt/Environment, June 11. – 15. 2000, Vol. 22 p. C 23
- [72]\* Labuda J., Vaničková M., Bučková M., Ferancová A.: Application of electrochemical biosensors based on DNA and cyclodextrin. In: *Book of Abstracts, Euroanalysis XI*, Lisbon, Portugal Sept. 3. – 9. 2000, p. OC - 40
- [73]\* Labuda J., Bučková M.: Metal Speciation analysis based on the kinetics of sensor-analyte interaction. In: *Book of Abstracts, Euroanalysis XI*, Lisbon, Portugal, September 3. – 9. 2000, p. P - 273
- [74] Labuda J.: Vývoj a praktické využitie elektroanalytických senzorov. *Development and Practical Utilization of Electroanalytical Sensors (in Slovak)*. *Conference Present state and perspectives of analytical chemistry in praxis*, Department of analytical chemistry, Faculty of chemical technology, STU, Bratislava, Slovak Republic, September 18. – 21. 2000, pp. 40 – 43
- [75]\* Laštincová J., Beinrohr E., Matušková L., Jurica E.: Determination of hazardous elements in soils after microwave digestion. *4<sup>th</sup> European furnace symposium and XVth Slovak spectroscopic conference*, Podbanské, Slovakia, 12. - 16. 6. 2000, Slovenská spektroskopická spoločnosť, 2000
- [76] Laštincová J., Beinrohr E.: Stanovenie vybraných rizikových prvkov v pôdach po mikrovlnnom rozklade. *Determination of toxic elements in soils after microwavedigestion (in Slovak)*. *Proceedings ACP 2000, VIII Conference Present state and perspectives of analytical chemistry in practice*, CHTF STU, Bratislava, Slovakia, September 18. -21. 2000, pp. 130 – 132
- [77] Laštincová J., Beinrohr E.: Vnútrelektródové coulometrické titrácie: Stanovenie amoniaku vo vodách.

- In-electrode coulometric titrations: determination of ammonia in waters (in Slovak). Proceedings Hydrochemistry 2000, VÚVH Bratislava, Slovakia, May 24. –25. 2000, pp. 101-104
- [78] Lehotay J., Čižmárik J., Hroboňová K.: Korelačné štúdie v oblasti lokálnych anestetík metódou neuronových sietí v HPLC. Correlation study of some local anaesthetic by neural net wo in HPLC (in Slovak). Sjezd České farmaceutické společnosti a XVI. lékárnické dny, Hradec Králové, Czech Republic, Abstract of lectures and posters, October 2000, p. 10
- [79] Lehotay J., Hroboňová K., Čižmárik J.: Štúdium interakcií pri separácii enantiomérov metódou HPLC. Interaction study of separation of enantiomers by HPLC (in Slovak). VIII th Conference Present state and perspectives of analytical chemistry in praxis, Department of analytical chemistry, Faculty of chemical technology, STU, Bratislava, Slovak Republic, September 18. – 21. 2000, p. 62 - 64.
- [80]\* Lehotay J., Hroboňová K., Krupčík J.: Determination of some pollutants by HRCG and HPLC. 23<sup>th</sup>. International symposium on capillary chromatography, Riva del Garda, Italy, June 5. – 10. 2000, Proc. J. 20, p. 1 - 8
- [81] Lehotay J.: Oplyvňovanie selektivity detekcie a derivatizácia. Summer school of HPLC, Bratislava, Slovakia, June 20. – 23. 2000, Book of abstract p. 30 - 37
- [82] Lehotay J.: Chirálné separácie v HPLC. Chiral separation in HPLC (in Slovak). Summer school of HPLC, Bratislava, Slovakia, June 20. - 23. 2000, Book of abstract p. 38 - 53
- [83] Lehotay J.: Trendy v HPLC. Trends in HPLC (in Slovak). Summer school of HPLC, Bratislava, Slovakia, June 20. – 23. 2000, Book of abstract, p. 88 - 97
- [84] Lehotay J.: Využitie HPLC pri analýzach vzoriek životného prostredia - legislatíva. Analýza emisií. HPLC possibilities of analysis of enviromentals samples – re (in Slovak). Summer school on HPLC, Bratislava, Slovakia, June 20. – 23. 2000, Book of abstract p. 190 - 192
- [85] Lehotay J.: Stanovenie emisií toxických látok - normatívne predpisy. Determination of emission of toxic compounds – standards (in Slovak). Ecology - Energy - Economy, Bratislava, Slovakia, June 2000, Book of abstract p. 14 - 16
- [86] Lehotay J., Čižmárik J., Hroboňová K., Armstrong D. W.: HPLC separácie enantiomérov zo skupiny opticky aktívnych derivátov kyseliny fenylkarbámovej. HPLC separation of enantiomers of some phenyl carbanic acid (in Slovak). XXIX. conference Synthesis and analysis of drugs, Bratislava, Slovakia, September 2000, Abstract p. 10 – 11
- [87] Lehotay J.: Stopová a ultrastopová analýza. Trace and ultratrace analysis (in Slovak). Book of Abstracts Advances in Chromatography and Electrophoresis 2000, Univerzita Pardubice Czech Republic, L 9 2 p.
- [88]\* Májek P., Špánik I., Krupčík P.: The clasification of cyclodextrin stationary phases by multivariate analysis, 23<sup>rd</sup> International Symposium on Capillary Chromatography, Riva del Garda, Italy, June 5. – 10. 2000
- [89] Manová A., Beinrohr E., Jurica L.: Elektrochemické generovanie hydridov pre AAS: Optimalizácia stanovenie As vo vodách. Electrochemical hydride generation for AAS: Optimisation of As analysis in waters (in Slovak). Proceedings Hydrochemistry 2000, VÚVH Bratislava, Slovakia, May 24. –25. 2000, pp. 189 - 196
- [90] Manová A.: Elektrochemické generovania hydridov pre AAS. Electrochemical hydride generation for AAS (in Slovak). VIII th Conference Present state and perspectives of analytical chemistry in praxis, Department of analytical chemistry, Faculty of chemical technology, STU, Bratislava, Slovak, September 18. – 21. 2000
- [91]\* Manová A., Beinrohr E.: Flow injection electrochemical hydride generation AAS for the speciation of inorganic selenium. Proceedings of 4<sup>th</sup> European furnace symposium and XVth Slovak spectroscopic conference, Podbanské, Slovakia, Slovak Spectroscopic Society, June 12. – 16. 2000, p. 43 - 47
- [92]\* Matisová E.: Carbon Sorbents and Their Utilisation for Preconcentration of Pesticides Residues in Wines with Subsequent HRGC and GC-MS Analysis. Research and European policy on Pesticide residues in Mediterranean Countries Athens, Greece, Abstracts, May 2000, p. 29 - 30
- [93] Matisová E.: Mikroextrakcia tuhou fázou a membránová extrakcia. Solid Phase Microextraction and membrane extraction (in Slovak). High speed gas chromatography and Preconcentration techniques, Millennium school, Department of analytical chemistry, Faculty of chemical technology, STU, Bratislava, Slovak republic, May 30. – 2. June 2000, p. 51 - 60
- [94] Matisová E.: Úvod do rýchlej plynovej chromatografie. High speed gas chromatography and Preconcentration techniques (in Slovak). Millenium School, Department of analytical chemistry, Faculty of Technology, STU, Bratislava, Slovak Republic, May 30. – 2. June 2000
- [95] Matisová E.: Príprava vzorky. Sample preparation (in Slovak). High speed gas chromatography and Preconcentration techniques, Millennium school, Department of analytical chemistry, Faculty of chemical technology, STU, Bratislava, Slovak Republic, May 30. – 2. June 2000
- [96] Matisová E.: Separačné a predkoncentračné techniky. Separation and preconcentration tecjniques (in Slovak). High speed gas chromatography and Preconcentration techniques, Millennium school, Department of analytical chemistry, Faculty of chemical technology, STU, Bratislava, Slovak Republic, May 30 .– 2. June 2000

- [97] Matisová E.: Perspektívy plynovej chromatografie. Perspectives of gas chromatography (in Slovak). VIII th Conference Present state and perspectives of analytical chemistry in praxis, Department of analytical chemistry, Faculty of chemical technology, STU, Bratislava, Slovak Republic, September 18. – 21. 2000
- [98] Mocák J., Balla B.: Metódy viacrozmernej analýzy dát v analytickej chémii. Methods of Multivariate Data Analysis in Analytical Chemistry (in Slovak). Conf. Proc. Current state and perspectives of analytical chemistry in practice, SSPCH, Bratislava, Slovakia, September 18. – 21. 2000, p. 21 - 24
- [99] Mocák J.: Konceptia a praktický výpočet neistôt pomocou PC softvéru. Concept and Practical Way of Uncertainty Calculation Using PC Software (in Slovak). Seminar Proc. Use of computer technique in chemical testing laboratories, Chemmea, Bratislava, Slovakia, April 4. 2000, p. 41 - 56
- [100] Mocák J., Balla B., Mičič S.: Vyhodnocovanie analytických výsledkov. Evaluation of Analytical Results (in Slovak). Seminar Proc. Rapid gas chromatography and pre-concentration techniques. Ed. P. Korytár. May 30. – June 2. 2000, SSPCH, Bratislava, Slovakia, p. 121 - 131
- [101]\* Mocák J., Bobrowski A.: Detection and Quantification Limits - New IUPAC Recommended Way of Calculation. In: Book of Abstracts. IVth European Furnace Symposium. Slovak Spectr. Soc., Podbanské, Slovakia, June 12. - 16. 2000, p. 49
- [102]\* Mocák J., Bond A. M.: Calculation of Current – Time Dependencies in Linear Scan Voltammetry Using an Infinite Series Solution. In: J. Heyrovsky Memorial Symposium. Czech Chem. Soc., Prague, Czech Republic, August 30. – September 1. 2000, p. 47
- [103] Mocák J., Varga Š.: Určenie medze detekcie a medze stanovenia. Determination of the Detection and Quantification Limits (in Slovak). In: 17th Seminar Data Analysis. Trilobyte, Pardubice - Bohdaneč, Czech Republic, May 3. – 5. 2000, p. 1
- [104] Mocák J., Balla B.: Mnohorozmerná analýza dát s akcentom na aplikáciu v klinicko-biochemickej praxi. In: Abstracts of lectures. Data Analysis 2000/II. Trilobyte, Pardubice - Bohdaneč, Czech Republic, November 21. – 24. 2000, p. 8
- [105] Netriová J., Brandšteterová E., Javorová S., Johannesová Z.: HPLC stanovenie morfinu a jeho metabolitov v klinických vzorkách. HPLC analysis of morphine and its metabolites in clinical samples (in Slovak). Conference Progress in Chromatography and Electrophoresis 2000, Bratislava, Slovakia, September 5. - 6. 2000, p. 66 - 67
- [106]\* Oswald P., Krupčík J., Špánik I., Bajdichová M., Sandra P., Armstrong D. W.: The use of a peak deconvolution method for computer assisted determination of energy barrier to enantiomerization in dynamic gas chromatography. International Symposium on Advances in Chromatographic and Electrophoretic Separation, Bayreuth, Germany, April 17. – 19. 2000
- [107]\* Pospíšilová L., Laštincová J., Fišera M., Brandšteterová E.: Quality of humic acids isolated from arable soil. Proceedings 10<sup>th</sup> International Meeting of the International Humic Substances Society, Toulouse, France, June 24. – 28. 2000, p. 277 - 277
- [106]\* Pospíšilová L., Laštincová J., Fišera M.: Stanovení rizikových elementu v půde metódou ICP AES v axiálním uspořádání. Determination of toxic elements in soils by axial ICP AES (in Czech). Proseedings The role and use of the results of pedology in ecology, University Olomouc, Czech Republic, pp. 140 – 145
- [107]\* Rievaj M., Tomčík P., Bustín D.: IDA microelectrode - a new sensor for some toxic species monitoring in environment. In: Book of Papers of the 20<sup>th</sup> International Symposium Industrial Toxicology 2000, Levoča, Slovak Republic, June 7. - 9. 2000, p. 101 - 104
- [108]\*\* Rievaj M., Tomčík P., Bustín D.: Využitie nových senzorov v ultra - stopovej analýze kovových polutantov vo vodách. Application of new sensors in ultra-trace analysis of metal pollutants in water (in Slovak). In: Book of Papers of the XXXIV conference Hydrochémia 2000, Bratislava, Slovak Republic, May 24. - 25. 2000, p. 221 - 231
- [109] Sádecká J., Hercegová A., Polonský J.: Determination of ascorbic and isoascorbic acid by capillary isotachopheresis. In: Book of Abstracts Advances in Chromatography and Electrophoresis, Pardubice, Czech Republic, September 5. – 6. 2000, p. 64 - 65
- [110] Sádecká J., Polonský J., Hercegová A.: Izotachoforetická analýza aditív do mäsových výrobkov. Isotachopheretic analysis of additives to meat products (in Slovak). 8th Conference Present State and Perspectives of Analytical Chemistry in Practice, Bratislava, Slovak Republic, September 18. - 21. 2000, p. 112 - 113
- [111]\* Slobodník J., Korenková E., Matisová E., Slavica B.: Hyphenation of Large Volume Injection Techniques and Fast Gas Chromatography/Mass spectrometry: Analysis of Environmental Samples. Papers edited on CD by Sandra P. and Racstraw A.J. In 23<sup>rd</sup> International Symposium on Capillary Chromatography, , Riva del Garda, Italy, June 5. – 10. 2000
- [112]\* Špánik I., Krupčík J., Oswald P., Sandra P., Armstrong D. W.: On the HRGC separation of enantiomers of N-TFA-O-alkyl derivatives of linear alkyl chain amino acids on alkylated  $\beta$ - and  $\gamma$ -cyclodextrin phases, International Symposium on Advances in Chromatographic and Electrophoretic Separation, Bayreuth, Germany, April 17. - 19. 2000

[113]\* Špánik I., Schmidt R., Schurig V.: The determination of thermodynamic parameters of Compound B, a degradation product of sevoflurane, by gas chromatography, 23<sup>rd</sup> International Symposium on Capillary Chromatography, Riva del Garda, Italy, June 5. – 10. 2000

[114]\* Špánik I., Krupčík J., Oswald P., Skačáni I., Gali M., Sandra P.: The study of enantioselectivity of alkylated  $\beta$  and  $\gamma$ -cyclodextrin derivatives towards the separation of enantiomers of linear alkyl chain amino acids, 23<sup>rd</sup> International Symposium on Capillary Chromatography, Riva del Garda, Italy, June 5. – 10. 2000

[115]\* Špánik I., Krupčík J., Oswald P., Sandra P., Armstrong D. W.: The influence of cavity size of 2,6-O-Dipentyl-3-O-TFA(OH)-CD on the enantiomer resolution of selected amino acids, 23<sup>rd</sup> International Symposium on Capillary Chromatography, Riva del Garda, Italy, June 5. – 10. 2000

[116] Tomčík P., Bustín D., Rievaj M.: Perspektívy mikroelektronických štruktúr v elektroanalýze.

Perspectives of microelectronic structures in electroanalysis (in Slovak). In: Book of Papers of the VIII conference ACP 2000, Bratislava, Slovak Republic, September 18. - 21. 2000, p. 93 - 94

[117] Vaničková M., Bučková M., Labuda J.: DNA biosenzory – ich príprava a analytické využitie. DNA biosensors - their preparations and analytical application (in Slovak). Conference Present state and perspectives of analytical chemistry in praxis, Department of analytical chemistry, Faculty of chemical technology, STU, Bratislava, Slovak republic, September 18. – 21. 2000, pp. 44 - 46

[116] Vrabel V., Oktavec D., Sivý J., Marchalín Š.: Kryštalová štruktúra a biologická aktivita 1,4 – dihydropyridínových derivátov. 8th Conference Present State and Perspectives of Analytical Chemistry in Practice, Bratislava, Slovak Republic, September 18. - 21. 2000, p. 139 - 140

#### C. Books and Textbooks

[1] Bobrowski A., Osmeda-Ernst E., Knap W., Mocák J.: Quality Assurance/Quality Control in Groundwater Monitoring. In: Conference Proceedings – IVth International Conference Water Supply and Water Quality. Edited by M.M. Sozanski. LEM Project SC, Krakow, p. 174 - 187 (2000)

[2] Borošová D., Mocák J., Beinrohr E., Bobrowski A.: Determination of Arsenic in Water – Quality Assurance and Calculation of Metrological Characteristics. In: Conference Proceedings – IVth International Conference Water Supply and Water Quality. Edited by M.M. Sozanski. LEM Project SC, Krakow, p. 75 - 80 (2000)

[3] Brandšteterová E., Kubalec P., Bovanová L. : HPLC Determination of Antimicrobial Residues in Edible Animal Products. In Food Analysis by HPLC. Edited by Leo M.L. Nollet, Marcel Dekker, Inc. New York, p. 621 - 693 (2000)

[4] Mocák J., Bobrowski A.: Determination of Cadmium and Lead in Water – New Way of Calculating Detection and Quantification Limits. In: Conference Proceedings – IVth International Conference Water Supply and Water Quality. Edited by M.M. Sozanski. LEM Project SC, Krakow, p. 121 - 132 (2000)

[5] Mocák J., Bobrowski A.: Detection and Quantification Limits – New IUPAC Recommended Way of Calculation. In: Contemporary State, Development and Applications of Spectroscopic Methods. Edited by E. Krakovska. VIENALA, Košice, Slovakia, p. 339 - 344 (2000)

[6] Sádecká J., Polonský J.: Capillary Isotachopheresis. In: Encyclopedia of Separation Science. Edited by Ian. D. Wilson, Academic Press, London, p. 1215 - 1222 (2000)

[7] Sádecká J.: Forensic Sciences. Capillary Electrophoresis. In: Encyclopedia of Separation Science. Edited by Ian. D. Wilson, Academic Press, London, p. 2862 - 2870 (2000)

[8] Tarapčík P., Čakrt M., Polonský J., Korgová E.: Analytical chemistry, Seminary exercises, p. 150, STU, Bratislava (2000)

#### D. Patents

#### E. PC Programmes

[1] Beinrohr E., Tarapčík P.: pH2 - General pH calculation for systems including up to nine acid-base compounds.

[2] Tarapčík P., Beinrohr E.: pH-titr - General calculation and presentation of acid- base titration curves.

[3] Tarapčík P., Beinrohr E.: distrib - Distribution diagrams for acid-base and complex equilibria

[4] Tarapčík P.: Set of solved analytical and chemical equilibria problems using the ECXEL spreadsheet