



Institute of Hydrochemistry

**Chair for Hydrogeology,
Hydrochemistry and
Environmental Analytical
Chemistry**

Annual Report

2003

Head of the Institute and Group Leaders 2003



U. Pöschl, C. Haisch, R. Nießner, M. Weller, T. Baumann, U. Panne, D. Knopp

Institute of Hydrochemistry
Chair for Hydrogeology, Hydrochemistry and Environmental Analytical Chemistry
Technische Universität München
Marchioninstr. 17

D-81377 München

Editor: Dr. Thomas Baumann

Editorial

Dear Friends and Colleagues,

the year 2003 was a difficult one, as expected. Not only the negotiations around the call to Dortmund (ISAS-Institute of Analytics) were pressing. The general funding situation in Germany became disappointing more and more. Several foreseen research grants were called off, and even long lasting project connections to foreign institutions were dropped. In view of this the upcoming discussion on elite universities can't be understood. The already exhibited damage in interrelationships is huge. Our home university TUM seems to follow this trend: For the first time reinvestment capital is spent only in tranches over 7 years! Exchange of old equipment or purchase of new instrumentation is nearly impossible by that. Surprisingly, a microbiological lab within our pilot scale lab became funded. Only strong institutes with saved money (however this was possible) can afford new routes. Withdrawal of personnel is continuing within the next years.

Also a formal change became valid on January 1st, 2004: The chair is now part of the newly established Department of Chemistry at TUM. Because of legal obligations the name "Institut für Wasserchemie und Chemische Balneologie" wasn't changed. So, in essence, the situation in Großhadern remains unchanged.

Fortunately, the various groups at the institute were working very successful. Especially the connections to the car manufacturers became tighter. As predicted some years earlier – the multidisciplinary competence of the institute makes independent. Within the house each group makes profit from the connections and financial success of the others. Again a very reputable publication record in high-ranking scientific journals proves this.

PD Dr. Panne became honoured 2003 with the reknowned Karl-Martens-Prize of the Bundesanstalt für Materialforschung, Berlin, for his continuous success with laser-based spectroscopy. Some calls on C 4-professorship in Analytical Chemistry followed. The youngsters are fledged with time . . .

From the teaching front I can report on the ongoing cooperation with our neighbour university LMU within Geosciences. The Bachelor programme has started in November 2003. An increase in Chemistry (Analytical, Organic) within the study course has been realised. In Singapore the Water Module within Industrial Chemistry became part of the curriculum for most of the students. The first Master students from Singapore prepared their thesis in Großhadern. Also the first Bachelor theses were made by students from LMU (Environmental Analytical Chemistry) and TUM (Biochemistry).

Unfortunately the trend of decreasing numbers of PhD students continues. With time we will have to perform our research with Post Docs or guest students from abroad only.

Nevertheless, I would like to thank all friends and promoters for their enormous help and input. Especially the permanent staff of the Institute is thanked a lot for their never ending efforts and enthusiasm – they provide the light at an otherwise dark horizon.

Reinhard Nießner
Head of the Institute



1 Research

1.1 Hydrogeology and Hydrochemistry

1.1.1 Development of a High-Throughput Test Design for the Determination of Sorption Parameters

Funding: IWC

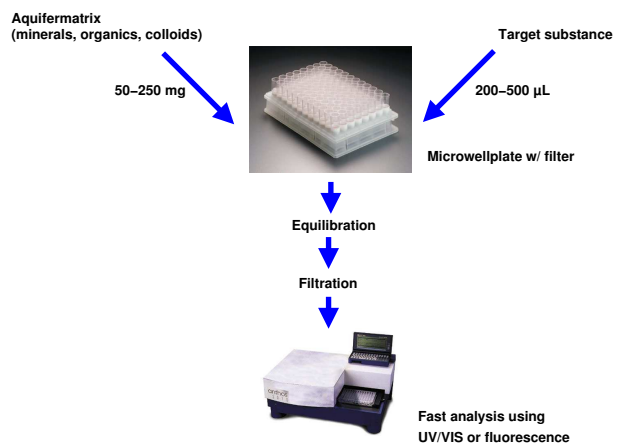
Groundwater is at permanent risk of contamination from various sources. For many emerging substances, whether intentionally or accidentally released into the environment, the transport properties are unknown. Therefore, any risk assessment has to cope with high uncertainty margins.

Sorption to the matrix of an aquifer is one of the processes controlling the transport velocity of contaminants. However, current methods to determine sorption parameters are limited by their high time and labour costs. Therefore, most studies focus on - more or less - characteristic environmental settings.

During the project a highly parallel sorption test design has been developed. This test design allows to put a multitude of different contaminant/matrix combinations on one single microwell plate. Furthermore the test design can readily be combined with established high-throughput analytical techniques.

However, when working with small quantities of the solid matrix, heterogeneity becomes a major issue. Unlike conventional batch tests, which are close to a representative elementary volume/mass, the micro-sorption test design has to provide homogeneity by reducing e.g. the variation of the grain size and the mineralogical composition.

It could be shown, that the sorption isotherm from a conventional batch experiment can be replaced with several individual sorption isotherms for the constituents of the matrix. Using this the data, the sorption test itself becomes more general and provides access to the process. (*O. Fenton*)



1.1.2 Development and Protection of Ground Water and Mineral Water

Funding: Private Enterprises

In the light of increasing emissions of contaminants into the environment, groundwater protection is one of the major objectives for the upcoming years. Detailed risk assessments are necessary to identify potential hazardous and to plan countermeasures.

Our research is focussed on scalable GIS based risk assessment tools which integrate aquifer properties, transport properties and spatial information to develop realistic risk scenarios. Another upcoming field of research is linked to the use of geothermal energy. Here, our main focus is on the hydrochemical processes in the thermal water and the implications on the long-term hydrochemical conditions in the catchment zones.

(*T. Baumann*)

1.1.3 Electrochemical Cleanup of Water Treatment Residues

Funding: BayFORREST F179

During the production of drinking water roughly 123.000 t (dry matter) of waterwork residues accrue each year. Roughly 3/4 of these sludges are disposed and only 1/4 are reused in other environments. In order to reduce the flux and to avoid accumulation of environmentally relevant contaminants, heavy metals and organic contaminants must not exceed given concentrations.

Based on the idea of electrochemical soil reclamation, the purpose of this project was a feasibility study to elaborate the chemical, mineralogical, and technical conditions for an electrochemical removal of heavy metal ions and organic contaminants from waterworks residues. A potential treatment process should be effective in terms of flux reduction, treatment time and treatment costs. Of course, the principal chemical and mineralogical characteristics of the sludge, which render the sludge useful for reuse in e.g. sewage treatment plants, must not be altered.

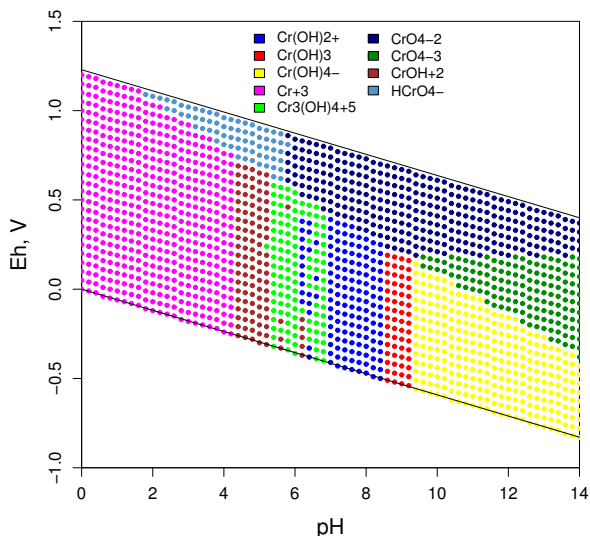
Electrokinetic treatment techniques are generally based on electrophoresis, electroosmosis and electrochemical processes at the electrodes. They usually involve a current source, often filter materials, ion selective membranes, or specific adsorber materials and sometimes electrolyte solutions for a better control of the geochemical conditions in the treated materials. Successful applications include treatment of contaminated soils, contaminated wood, or sewage sludge.

In contrast to these, the waterworks residues present a matrix which is rather sensitive to changes of the pH/Eh conditions. Gibbsite, which is one of the major constituents of the residue is stable only in the neutral pH range and dissolves at higher and lower pH values as they occur at the electrodes. Even moderate treatment conditions and pH-controlling electrolytes led to a quantitative dilution of the sludge. Once dissolution takes place, the major constituents of the sludge are transported to the corresponding electrodes and removed from the system. Afterwards the a reformation of sludge is impossible.

Investigations also showed, that the heavy metal ions rather seem to be integrated into the Gibbsite flakes than adsorbed to the surface of the sludge. Therefore it seems impossible to remove the heavy metal ions without a destruction of the matrix.

Given the results of the experiments in the laboratory scale an application of electrochemical methods to remove heavy metal ions from waterworks residues does not seem feasible.

(D. Spangenberg)



1.1.4 Statistical Methods for the Assessment of Leachate Concentrations at the Point of Compliance

Funding: BMBF 02WP0175

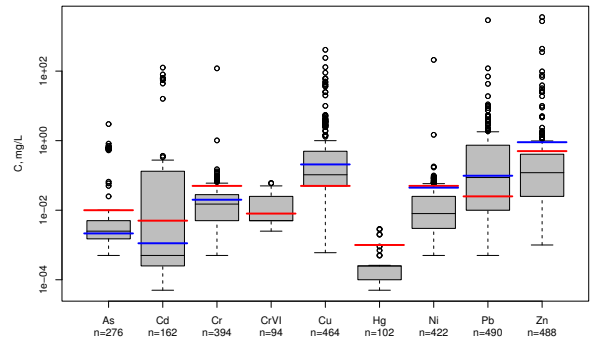
In order to protect the groundwater against pollution from contaminated sites, the German Guideline on Soil Protection stipulates, that the source strength of contaminants (Quellstärke) must be investigated prior to the deposition of partly hazardous material such as bottom ash from municipal solid waste incinerators.

With respect to the heavy metal content of the bottom ash, it is important to determine conclusions to the environmental impact of the bottom ash material. Several authors have described a dependency of heavy metal concentration from the pH value and the storage time. Because bottom ash is often used in road construction, it is important to assess the mobility of heavy metals in contact with water under different conditions. In order to describe the potential risk of a bottom ash material transferred into nature, it is necessary to find a proper way of extraction describing the way of leaching under natural conditions.

In the current project we could show by statistical methods (multivariate regression, factor analysis, clustering), that the heavy metal concentration in the leachate from 28 different incineration plants all over Germany is neither influenced by any technical parameter of the incineration plant nor by the waste composition and amount. In toto, bottom ash can be described as a rather homogeneous material. There is statistical evidence that the heavy metal concentrations in three different bottom ash disposals can be approximated with the concentration in the leachate from the DEV-S4 extraction test performed with bottom ash, stored for one year prior to the test. The results from the other elution tests such as the soil saturation extract, the Swiss elution test as well as the DEV-S4 with 'younger' bottom ashes seems to overestimate the dissolvable heavy metal content in the bottom ash material.

Available data suggests an exponential decrease of leachate concentrations with time, which is very similar to the observed exothermal reactions in the MSWI bottom ash material. This knowledge gives us the possibility to predict the heavy metal concentration in the S4 extract at any time of bottom ash aging. The underlying hypothesis is, that the carbonization of the bottom ash, which was measured independently, not only reduces the availability of reactive phases in the bottom ash, thus leading to a decrease of the heat production. These coatings also reduce the availability of the metal ions, thus leading to reduced leachate concentrations.

(R. Biber)

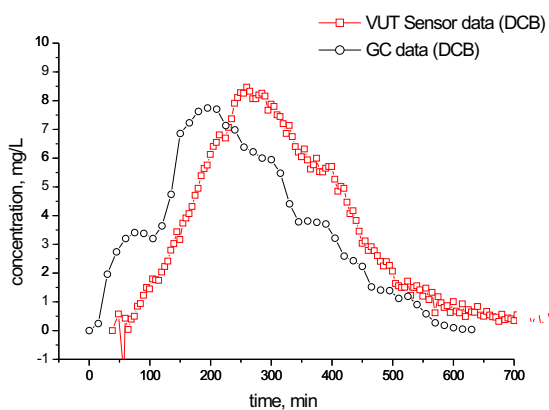


1.1.5 In Situ Monitoring for Soil and Water by Infrared Sensing

Funding: EU EVK1-CT-1999-00042

Cooperation: Fraunhofer-Institut für Physikalische Messtechnik, Freiburg; Technische Universität, Wien; Universität für Bodenkultur, Wien; Tel Aviv University; Université de Rennes; CSIC, Barcelona

A high latent and real potential of environmental hazards & health implications from landfills and leakage still remains, since multitudinous of these landfills are presently not state of the art. This is caused by nonexisting flexible membrane linings, missing mineral base linings and the lack of seepage collecting & treatment systems. Contrary to numerous European efforts for the reduction and prevention of waste, the production still increases. So nearly 60% of domestic and more than 65% of hazardous waste are still deposited in landfills. Due to this fact, ground- and surface water in the surrounding of these installations is exposed to the risk of contaminations for a long time. Consequently the requirements for an continuous control and survey of leakage and landfill contaminations increased. Abandoned waste sites need to be screened and monitored for possible release of organic matter, too.



Within the scope of the IMSIS project (In Situ Monitoring of Landfill Related Contaminants in Soil and Water by Infrared Sensing) fibre-optic evanescent wave sensor systems for the detection of organic pollutants (BTEX, PAH, etc.) in groundwater and seepage are developed.

In this consortium the Institute of Hydrochemistry and Chemical Balneology at the Technical University of Munich (IWC) provides laboratory and pilot scale facilities for experiments with the IMSIS sensor systems. Besides IWC selects and offers adapted field test sites for real-world experiments. For these experiments possible fields of application are presented and the legal issues for measuring campaigns settled. IWC characterizes the contaminated sites hydrochemically and hydrogeologically. Besides, the representativeness of the sensor measurement

data for the total contamination is evaluated.

Respectively the response behaviour of the new developed sensor systems for short and long term changes is verified. Therefore numerous experiments have been carried out at the IWC pilot scale facilities. In addition, the long term stability of the system - especially the composition and the effects of organic and inorganic coatings - are investigated. Particulate appearing H_2S from sulfur reducing ambience on landfills, showed to corrode and destroy the silver halide fibers of the IMSIS-systems. Except chalcogenide glass fibres from one project partner showed no interference to the H_2S .

After a calibration of the detecting unit, it is possible in noncorrosive systems not only to prove the existence of organic pollutant groups like VOC, BTEX, PAH, phenols or alike. Rather there is the opportunity to discriminate single substances like tetrachloroethylene (TCE) or dichlorobenzene (DCB), or to filter the information for single substances out of the measured spectral data, by using spectral databases. A real world experiment was performed in contribution with UFZ-SAFIRA pilot plant in Bitterfeld (Umweltforschungszentrum Halle-Leipzig), Saxony-Anhalt. Different technical approaches (usual sensor set-up, miniaturized spectrometer), sensor parts (fibres, coatings, ATR-crystals) and reference methods were tested in these sets of experiments successfully.

The developed IMSIS sensor system comprises a portable Fourier transform infrared spectrometer (FT-IR), coupled with a silver halide fibre-optic cable leading to the sensorhead and back to the detection unit of the spectrometer. The detection limit for the sensor system is in the mg/L range, while the enrichment of the pollutants within the polymer coating of the fibre takes a few minutes. The sensorhead should be inserted in monitoring wells and be placed 10 - 20 m below the ground surface both in varying depths and at different places within one site.

The IMSIS-system is to be used for short to medium term surveillance of ground-water monitoring wells, or be fixed for long-term surveillance. In addition, the system is to be installed at new built landfills in Europe.

Particular at the planning of clean ups and the critical phase of decontaminations, a flexible field measuring system is useful for a fast and steady contribution of analytical data.

(M. Alte)

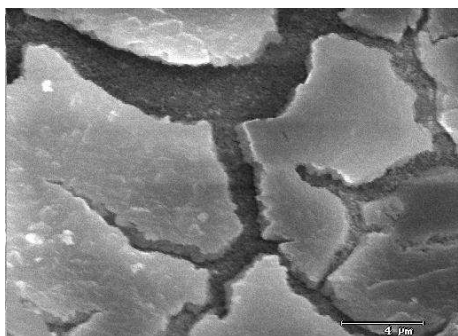
1.2 Bioanalytics I

1.2.1 Determination of Sulfonylurea Herbicides Using Combined Immunoaffinity Extraction-Liquid Chromatography-MS

Funding: DFG Kn 348/8-1 (with support from Dr. J. Wenger, Syngenta, Basel)

Cooperation: Fraunhofer Institute of Molecular Biology and Applied Ecology (Schmallenberg)

Sulfonylureas are a class of herbicides, that are popularly used for a variety of crops because of their high herbicidal activity and low toxicity to mammals. Because of the low use range and their chemical characteristics such as thermal instability, monitoring of these herbicides in environmental samples needs techniques for sample enrichment and purification prior to chromatographic analysis.



Specific interactions between antigens and antibodies allow their versatile applications in immunoaffinity chromatography by employing immobilized antibodies. In residue analysis, for example, a high degree of molecular selectivity can be achieved using this technique. Several supporting matrices have been chosen for the preparation of immunosorbents. One of the emerging techniques is the encapsulation of antibodies in porous silicate glass by the sol-gel technology. Corresponding supports have been shown to be relatively inert while preserving the biological activity of the encapsulated protein. As a disadvantage, fragility of the sol-gel glass can lead to unwanted abrasion and, therefore, confine its application in chromatographic columns. Therefore, one aim of the project is to create more robust immunoaffinity columns by coating porous particles with a sol-gel glass layer. First, various parameters of the sol-gel process were optimized in order to maintain high activity of the immobilized antibody. Here the drying process (aging) that correlates with the pore size turned out to be the most important factor. On REM pictures of the coated particles, sol-gel material can be found also on the particles' surface and is not completely absorbed inside the pores as proposed. Anyway, first experiments to check abrasion show a significant reduction compared to pure crushed sol-gel, if not a total absence.

In this project, antibodies could be prepared against sulfonylurea herbicides using a complete molecule or only different structural parts as haptens. Antibodies with broadest specificity were immobilized in sol-gel glasses. Recovery experiments have shown that up to 19 compounds could be enriched from a mixture of 26 different sulfonylurea herbicides. For 12 compounds, recovery exceeded 60%. In parallel, the best antiserum was used to establish both direct and indirect competitive ELISA which were applied to analyze different tap and surface water samples.

(P. Degelmann, S. Egger)

1.2.2 Preparation of Monoclonal Antibodies with High Selectivity for Benzo[a]pyrene

Funding: BMBF 02WU0290

In the new European Community Directive for Drinking Water (Guideline 98/83/EC) a limit value of 10 ng/L was set for benzo[a]pyrene (BaP), one of the most potent carcinogenic PAHs. Immunochemical methods offer rapid detection and allows miniaturization for portable devices. Measurement in aqueous samples is often performed without any pre-treatment. So far, no antibody is developed that could detect only one

single PAH compound. Unspite whether this will be possible anyhow, triggering selectivity by preparation of appropriate haptens and suitable strategies for monoclonal antibody production is reality, yet. The present investigation will report first results on the generation of monoclonal antibodies with main specificity for benzo(a)pyrene.

For the immunization of mice, three BSA-conjugates and three KLH-conjugates, all of them with the same spacer length, were used. After different booster injections spleen cells were fused with a myeloma cell line. So far, 9 positive hybridoma cells were selected which showed reaction with benzo(a)pyrene-protein conjugates but not with the carrier protein itself. Supernatants of these cell clones were submitted to detailed investigation, i.e. to test affinity and specificity of the corresponding antibodies by running a competitive enzyme-linked immunoassay.

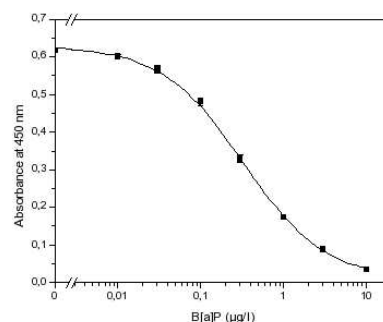
With each supernatant, benzo(a)pyrene calibration curves could be established. Experimental conditions of the immunoassay such as the kind of coating antigen and the dilution of the hybridoma supernatant were optimized. 12 coating antigens with different length of linking bridge at different position were screened, and the dilution of the supernatant was tested in the range of 1:100 - 1:2000. The calibration curves were plotted in the form of absorbance against log C.

The sensitivity of the assay was expressed by the value of IC_{50} , i.e. the concentration of analyte at the calibration curve producing 50% decrease of maximal response signal. The lower the value of IC_{50} , the higher the sensitivity of the assay. For the 9 positive supernatants, the sensitivity varied considerably. The IC_{50} values from 5 supernatants were observed in the range of 22.7-99.9 $\mu\text{g}/\text{l}$, while for other 4 supernatants the IC_{50} values were lower than 10 $\mu\text{g}/\text{l}$. So far, the superior antibody was from clone 25C8 which, with an IC_{50} of 0.35 $\mu\text{g}/\text{l}$ and a quantification range (20 to 80% A_{max}) of 0.04 to 2 $\mu\text{g}/\text{l}$, exhibited outstanding sensitivity.

The specificity of the supernatants was examined by cross-reactivity (CR) measurements. 17 structurally related PAHs were included in the study. The obtained CR values were significantly different from one supernatant to another. Interestingly, clone 25C8 not only showed highest sensitivity but also highest specificity for benzo(a)pyrene as well. For 14 of the PAHs CR was lower than 15% or totally negligible. Best cross-reactants were perylene (55%), chrysene (52%) and benzo(k)fluoranthene (35%).

Although monoclonal antibody 25C8 is the most sensitive and specific antibody against benzo(a)pyrene ever announced, additional immunizations and fusions are presently performed. Screening of hybridomas will reveal whether another antibodies of yet higher quality could be generated. Meanwhile, higher amount of this antibody will be prepared and purified. Then, it will be tested for the determination of benzo(a)pyrene in real water samples, i.e. for monitoring drinking water.

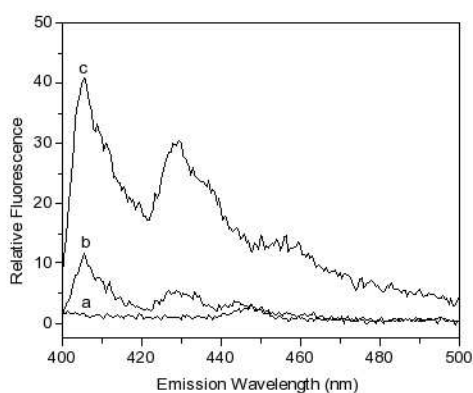
(D. Matschulat, A. Deng)



1.2.3 Production of Polyclonal Antibodies Against Homocysteine

Funding: Hong Kong University of Science and Technology (Prof. R. Renneberg) and IWC/TUM

Homocysteine is a non-essential thiol-containing amino acid formed as an intermediate during the metabolism of methionine. Normal basal concentration in blood plasma ranks from 5 to 15 μM . Elevated concentration of homocysteine has become a focus of research interest since it was established as a clinical risk factor for vascular dysfunctions that may lead to arteriosclerosis, stroke as well as cerebrovascular, peripheral vascular and coronary heart diseases. This is the background for the steadily increasing demand for the analysis of this compound in plasma. As analytical methods, GC-MS, LC-MS-MS, HPLC, CE, and immunoassays are applied. The latter is performed either as fluorescence polarization immunoassay, chemiluminescence immunoassay, or ELISA.



All immunoassays use the same commercially available antibody which was prepared against an S-adenosyl-L-homocysteine conjugate. As a consequence, sample preparation includes enzymatic conversion of free homocysteine to S-adenosyl-L-homocysteine by the action of S-adenosyl-L-homocysteine hydrolase. Mainly because of this and a second enzymatic step in sample preparation the immunoassay is rather time-consuming and costly. If a specific antibody could be prepared directly against homocysteine its use would facilitate immunological analysis significantly. Because of the small size of the analyte, its structural similarity to several other compounds which are formed in different metabolic pathways, antibody generation is an enormous challenge.

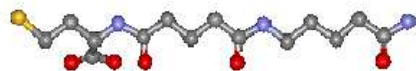
This project is devoted to this challenge. Based on new analyte-protein conjugates new immunizations were started. Presently, gained antisera are characterized and main efforts are directed on the development of assay formats which circumvent “bridge recognition”.

(A. Deng)

1.2.4 Biomimetic Optical Sensors for Environmental Endocrine Disruptor Screening (MENDOS)

Funding: EU (QLK-4-CT2002-02323)

During the last years endocrine disrupting chemicals (EDCs) have become suspects in various reproductive anomalies in humans and wildlife, mimicking the behaviour of estrogen and other endogeneous hormones. The aqueous phase is the dominant environmental distribution system for these compounds. The main goal of this project is the development of novel artificial receptor based optical sensor systems and their application for assessing and screening EDCs in the environment. The artificial receptors are prepared by molecular imprinting technology.



First, we focused on imprinting benzo(a)pyrene. This compound is one of the best known carcinogenic PAH and is also considered to act as an endocrine disruptor. To our knowledge, only two groups reported so far on molecular imprinting using PAHs as template/analyte. One group used PAHs of different size and shape from naphthalene (two rings) up to perylene (four rings) and cross-linked polyurethane as the polymer matrix

with no further functional monomer. The second group described the preparation of MIP for 1-hydroxypyrene, based on divinylbenzene and styrene. Generally, imprinting PAHs is difficult, because non-covalent interactions like hydrogen bond, dipolar and/or ionic interactions cannot be formed. There only remain hydrophobic interaction, steric cavity, and $\pi - \pi$ interaction which are one or two orders of magnitude weaker than the electrostatic forces.

In the first part of the project, three different monomers and two cross-linkers were selected to synthesize six kinds of imprinted polymers. Further, both bulk polymerization and suspension polymerization was applied. The affinity and selectivity of the synthesized polymers to benzo(a)pyrene and nine other PAHs was investigated in detail with rebinding, solid-phase extraction and HPLC experiments.

All the results indicate that the polarity of both monomer and cross-linker play an important role for affinity and retention behaviour. The affinities of the polymer to the analyte increased with the decreasing polarity of monomer and cross-linker. No significant difference in the affinity to benzo(a)pyrene was observed between MIPs and MIMs (molecularly imprinted microspheres). The preparation of nanoparticles and affinity layers on sensors is presently under investigation.

(J.-P. Lai)

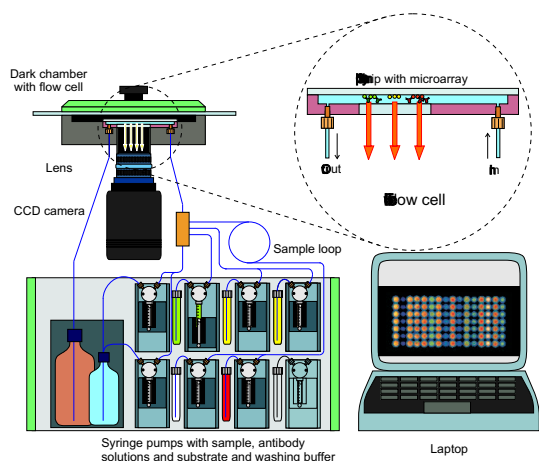
1.3 Bioanalytics II

1.3.1 Development of a Biosensor for the Rapid and Simultaneous Detection of Antibiotics in Milk

Funding: Forschungskreis der Ernährungsindustrie, FEI

Cooperation: LMU Munich (Prof. Märtlbauer)

The presence of antibiotic residues in milk due to improper use can lead to allergic reactions and the harm of the intestinal flora. There is also concern about increasing bacterial resistance to antibiotics. In the dairy industry, contaminated milk can result in the production problems of cultured products (yoghurt and cheese) due to the inhibition of starter cultures causing significant economic losses.



For consumer protection, regulatory authorities have established residue limits (MRL) for several antibiotics in bovine milk (EC Regulation 2377/90). Microbial inhibition (e.g., agar diffusion) assays are commonly used as screening tests. One disadvantage of these methods is the duration of about three hours. Usually the results are obtained, when the milk is already in production. For this reason dairies use quick tests which can detect the frequently used β -lactam antibiotics before the milk is pumped out of the dairy van to avoid troubles with fermentation steps in the milk processing. Other antibiotic groups than the β -lactams can not be determined with these tests. Furthermore, the dairy has to dispose the whole milk of a dairy van in case of a positive test result. To avoid the contamination of the already collected milk a sensor would be very helpful, which enables the rapid detection of all relevant antibiotics before the

milk is pumped into the dairy van.

The basis for this sensor is the PASA system (Parallel Affinity Sensor Array) which allows the transfer of an indirect ELISA onto a biochip. Analyte molecules are immobilized as haptens in an array of spots on a biochip. The glass chip is silanized to obtain reactive epoxy groups on the surface. Hapten protein conjugates can bind covalently and by adsorption. The spots are created by a non-contact spotting system with a piezo pump. The diameter of the spots is about $350\ \mu\text{m}$ with a spot distance of $0.6\ \text{mm}$. The disposable chip is inserted in a flow cell of about $100\ \mu\text{L}$ volume, where all incubations and reactions are carried out automatically.

At present the simultaneous detection of the following analytes is possible in whole milk (detection limits and MRLs in brackets): Penicillin G ($3.3\ \mu\text{g/L}$, MRL: $4\ \mu\text{g/L}$), cloxacillin ($0.29\ \mu\text{g/L}$, MRL: $30\ \mu\text{g/L}$), cephapirin ($0.12\ \mu\text{g/L}$, MRL: $60\ \mu\text{g/L}$), sulfadiazine ($3.49\ \mu\text{g/L}$, MRL: $100\ \mu\text{g/L}$), sulfamethazine ($4.93\ \mu\text{g/L}$, MRL: $100\ \mu\text{g/L}$), streptomycin ($5.1\ \mu\text{g/L}$, MRL: $200\ \mu\text{g/L}$), gentamicin ($12.1\ \mu\text{g/L}$, MRL: $100\ \mu\text{g/L}$), neomycin ($31.8\ \mu\text{g/L}$, MRL: $1500\ \mu\text{g/L}$), erythromycin ($0.36\ \mu\text{g/L}$, MRL: $40\ \mu\text{g/L}$) and tylosin ($0.95\ \mu\text{g/L}$, MRL: $50\ \mu\text{g/L}$). Penicillin G could be detected at the maximum residue limit (MRL), the detection limits for all other analytes were far below the respective MRLs. The tests require no sample preparation and can be carried out within 4 minutes 50 seconds. For the quantification of samples first a calibration with 5 chips is performed. The test of samples each spiked with five analytes could be demonstrated successfully. Different fat contents of the milk had no influence on the results.

(B. Knecht)

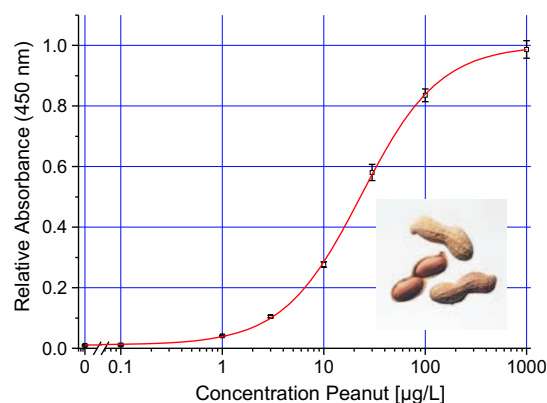
1.3.2 Development of Immunochemical Methods for the Detection of Food Allergen Traces

Funding: EU QLRT-2000-01151 Cooperation: IFA Tulln, Austria (Prof. Krska); RIKILT, The Netherlands (Dr. Haasnoot); CSL, UK (Dr. Banks); r-Biopharm, Germany (Dr. Schmitt); UNIMI, Italy (Prof. Restani); VU, Belgium; CMHT, UK (Dr. Wilson)

Lack of complete knowledge about the food composition may be hazardous for allergic patients. Even traces of certain proteins can result in fatal reactions so the only effective measure for these individuals is an avoidance diet. This, however, could be undermined by “hidden allergens” which may be caused by cross contaminations, for example in chocolate, cookies and ice cream or in food prepared in restaurants.

Allergies to peanut and hazelnut proteins are particularly prevalent and severe. Hence, our project is focused on the development of detection systems for these allergens. There is a need for sensitive lab-based immunoassays (ELISA) for routine analysis and rapid easy-to-use test strips, which might be even used by the consumer. Up to now we received about 100 different antibodies from our partners, monoclonal as well as polyclonal ones from several species. We characterized all the antibodies applying various test formats to get information about affinities and application conditions such as dilution factors or incubation times. Furthermore, we had to identify matching pairs; antibody combinations which are suitable for sandwich immunoassays. Homologous as well as heterologous pairs were screened, especially combinations consisting of two monoclonal mouse antibodies. For both peanut and hazelnut detection we found various matching pairs which showed excellent sensitivities.

(M. Kiening)

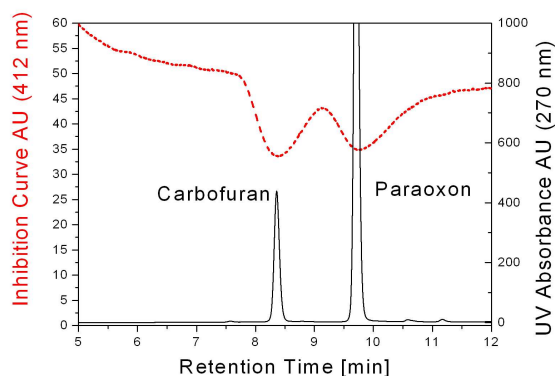


1.3.3 Development of a Method for Effect Related Analysis of Toxins

Funding: BMBF 02WU0331

Cooperation: Institute of Technical Biochemistry (Stuttgart), German Research Centre for Biotechnology (Braunschweig)

Groundwater and surface water are often contaminated by a complex mixture of chemicals, which could be of anthropogenic or environmental origin. The enormous variety of the compounds prevents a complete chemical analysis. The relevance of the substances for the ecosystem and human health is usually assessed by using biotests. Test organisms are mussels, algae, fishes as well as microorganisms such as luminescent bacteria. However, with these tests only the acute toxicity to the specific organisms can be assessed and no information on the compounds causing the effects is provided. Furthermore, besides toxic substances, the mixture could contain substances like pharmaceuticals, which may show unwanted effects to the ecosystem. The effect-related analysis combines chemical analysis and toxicity tests. After a physicochemical separation the substances pass a biochemical detector. In this detection unit biomolecular recognition elements are embedded, which detect a potentially toxic effect of the analyte.



The aim of this project is the multidimensional effect-related analysis for toxins based on online biochemical detectors and spectrometric methods. Several molecular target structures should be implemented in the biochemical detection unit for the parallel measurement of various toxicants. For the first set-up the enzyme acetylcholine esterase was chosen as a model target. Compounds, such as insecticides, but also natural substances from for example cyanobacterias like anatoxin-a(s) show neurotoxicity by inhibiting acetylcholine esterase. For the effect-related analysis a chemical separation via high performance liquid chromatography was hyphenated with an on-line enzyme inhibition test. The analytes (pesticide standards) were separated with a C18 column and after a flow split introduced into a fluidic system, where enzyme solution and a substrate-reagent mixture were pumped continuously. The substances eluting direct from the column were detected at 270 nm. In the biochemical detection unit with two knitted reaction coils the toxicants were detected by the inhibition of the activity of the enzyme. The activity of the enzyme was detected by Ellman's reagent at 412 nm. The parallel recording of the UV signal and the signal of the enzyme detector resulted in two chromatograms with overlapping negative (enzyme detector) and positive (UV detection) bands as shown in the figure. By the use of the reaction coils to enhance the inhibition at the one side and the colour development at the other side the peaks were broadened seriously and the high resolution of the HPLC was partially lost in the enzyme detector.

(*S. Maier*)

1.4 Laser Spectroscopy I

1.4.1 Microanalysis Using the Laser-Induced Plasma Spectroscopy (LIPS) and VUV-Echelle Spectrograph

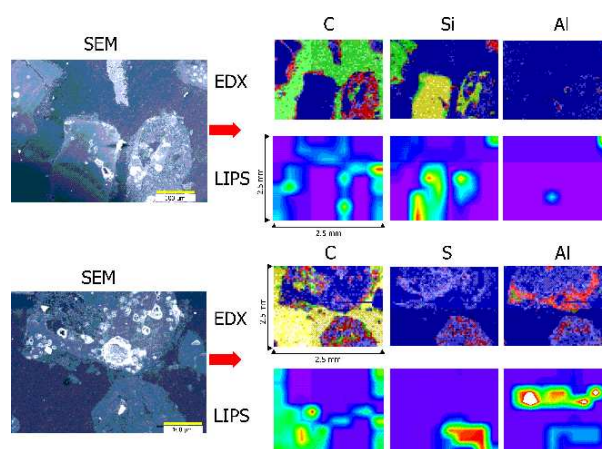
Funding: DFG Pa 716/2-1

Cooperation: ISAS, Berlin

Since the early days of laser spectroscopy, laser ablation in combination with optical emission spectroscopy or mass spectrometry has been utilized for spatially-resolved analysis. Laser-induced plasma spectroscopy (LIPS, or laser induced breakdown spectroscopy, LIBS) has been recognized early as potential tool for microanalysis. In contrast to other techniques), LIPS offers the prospect of a fast and highly automated at-line analysis without or only minor sample preparation.

The objective of this work was to extend the range of elements for microanalysis by LIPS, via observation of atomic emission in the VUV (120-200 nm) range. This permits not only a multielement analysis of metals, but also access to emission lines of metalloids such as S, P, N, O, C, and As. Two experimental set-ups for VUV-LIPS were realized: A set-up for bulk analysis based on conventional Czerny-Turner monochromator and a new echelle spectrograph. With the latter a new set-up for microanalysis by laser-induced plasma spectroscopy (LIPS) in the VUV range was designed. The system features an integrated ablation and detection module with a VUV echelle which permits a full spectral coverage between 150 and 300 nm with a resolving power between 11000 - 15000. At present, the ablation module permits a microanalysis with a crater size of 25 μm and a nominal depth resolution with an ablation rate of 150 nm per pulse. The VUV performance was demonstrated for bulk analysis of steel, detection limits for sulphur, carbon, and phosphorus were in the lower mg/kg range. The VUV scanning and mapping performance for heterogeneous matrices was illustrated for mineral bottom ash samples from a waste incineration process.

(Igor Radivojevic)

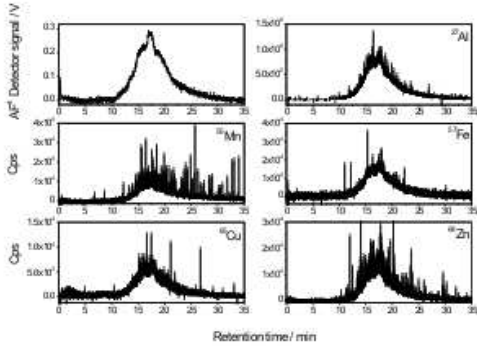


1.4.2 Investigation of the Colloidal Transport in Biological Sewage Plants Using AF⁴ and ICP-MS

Funding: DFG Pa716/4-1

Cooperation: Institute of Water Quality Control and Waste Management, TUM (Prof. Wilderer)

The goals of this project are the investigation of interactions of artificial tracer colloids with biofilms in laboratory reactors and technical plants, and the characterization of hydrocolloids in biological sewage plants. Several spherical lanthanoide(III)phosphate colloids with different size distribution have been synthesized by slow increase of pH in solutions which contain soluble rare earth metal salts and phosphoric acid. The best results have been received with Thulium, which will be used as tracer colloid in the future. At present experiments at a biofilm reactor containing a bacteria strain, which is able to degrade 2,4-D are carried out to receive informations about interactions of tracer colloids with biofilms.



Asymmetrical flow field-flow fractionation (AF⁴) was applied to characterize aquatic colloids from different sewage plants. This technique permits a fast size-selective separation of colloids under very careful conditions. For calibration, monodisperse polystyrene sulfonate standards (PSS) were used. To further characterize the nature of the colloids, especially the size distributions of heavy metals, the AF⁴ system was combined with online inductively-coupled plasma mass spectrometry (ICP-MS) analysis. The size distribution is determined by AF⁴ with UV absorbance and fluorescence detection and compared with the size information obtained by ICP-MS detection. Among numerous samples from different municipal biological sewage plants industrial plants were investigated. The fulvic/humic acid fraction with a size < 10 nm appears to be very similar in all samples and decreases only a little along the plants, whereas larger col-

loids > 10 nm almost completely pass into the sewage sludge. The concentrations of the heavy metals with exception of iron normally decrease along the plants. The results show that the used technique is suitable to characterize colloids in wastewater treatment plants and to receive informations about their whereabouts and interactions with biofilms. Further enhancement in sensitivity will be achieved in the next time using the so-called slot-outlet-technique, which enables an enrichment of the colloidal particles inside of the AF⁴ channel.

(H. Prestel)

1.5 Laser Spectroscopy II

1.5.1 Commercialization of the Photoacoustic Sensor System

The Photoacoustic Soot Sensor (PASS) is a time-resolving measuring system for the quantification of soot mass in exhaust gas, mainly of combustion engines. The development of this instrument was partially funded by the VFI. Over the last years, the system was optimized and a second prototype constructed, which is routinely in use a common project of the institute and MAN Nutzfahrzeuge GmbH. Furthermore, AVL List GmbH, a world leading company in powertrain engineering and automotive measuring and testing equipment decided to commercialize the system. First prototypes are expected to be available in summer 2004.

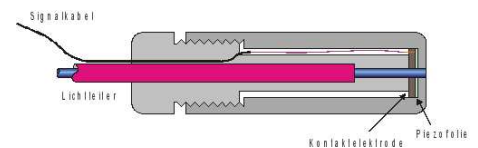
(C. Haisch)

1.5.2 Optoacoustic Tomography

Funding: IWC

One focus of the Laser Spectroscopy II group is the development of an optoacoustic (OA) tomography system for medical applications. The principle of this technique is the conversion of optical pulses in pressure signals by absorption and thermal expansion. The light pulses, created by a pulsed tuneable laser system are delivered to the sample, e.g. the biological tissue. The pressure pulses are detected by piezoelectrical sensors and converted in electrical signals.

An endoscopic system, containing fibre optics and piezo sensors, was developed and constructed. It was tested on layered and inhomogeneous Agar/Agar hydrogel samples, which serve as model for biological samples. Engraved channels, filled with absorbing dyes of well-defined absorption, where scanned with the optoacoustic endoscope. The diameter of the endoscope is now 10 mm, but it can be minimized to 6 mm and less. A sketch of the endoscope setup can be seen in the Figure.



The next step in the endoscope development and testing project are applications on animal and human material. This step will be carried out in close cooperation with the Laser Laboratory of the Klinikum Grosshadern and other clinical partners.

(C. Haisch)

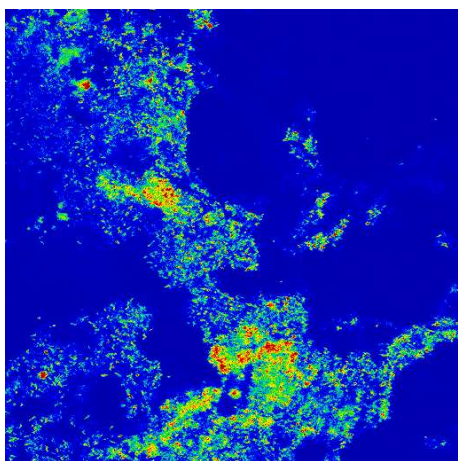
1.5.3 Biofilm Monitoring by Photoacoustic Spectroscopy (PAS)

Funding: DFG Ni 261/14-1, Max-Buchner-Forschungstiftung

Cooperation: Institute of Water Quality Control and Waste Management

Biofilms are layers of microorganisms embedded in a matrix of extracellular polymer substances (EPS). Life inside an EPS matrix offers many advantages for bacteria and protozoa. The cells can form microconsortia with relatively high mechanical stability and high cell density in which the degradation of complex substrates can be performed orchestrated and synergistically. The EPS matrix can absorb nutrients and is a protective barrier against biocides, changes of the physico-chemical conditions, phagocytosis, and some predator species. The undesired deposition of biological material on solid surfaces is termed biofouling and is caused often by the growth of biofilms. Biofouling can occur in almost every technical system under extremely diverse conditions. Biofilm growth on heat exchangers can seriously decrease the heat transfer efficiency. Biofouling increases the frictional resistance in tubes and on ship hulls. Biofilm flocs which

are detached from tube surfaces can clog tubes, valves, and nozzles. In membrane processes, biofilms increase the pressure differences and can lead to membrane clogging. Due to the decrease in water quality, biofouling must be controlled in drinking-water reservoirs and distribution systems as well as in food processing systems. Additionally, biofilms can provide a habitat for pathogenic microorganisms. The most important beneficial application of biofilms are biofilm reactors for wastewater treatment. In such reactors, immobilized bacteria and protozoa are used for degradation of organic and inorganic pollutants. For both, process optimization of wastewater treatment plants and enhancement of biocide efficacy, a nondestructive technique for online and in situ analysis of biofilms is necessary.



For nondestructive monitoring of biofilms, spectroscopic techniques based on light absorption and scattering are used. Within this project, a new biofilm monitoring technique was developed and optimized which is based on photoacoustic spectroscopy (PAS). PAS combines features of optical spectroscopy and ultrasonic tomography and allows – in contrast to other spectroscopic techniques – a depth-resolved analysis of both optically and acoustically inhomogeneous media. Additionally, PAS allows optical absorption measurements even in strongly scattering or optical opaque media. A more detailed description of the photoacoustic effect and the experimental setup used in this study can be found in the annual report 2002 of the Institute of Hydrochemistry.

The new biofilm monitoring technique allows the investigation of growth and detachment processes. By depth-resolved measurements, the thickness of the biofilm can be measured with a resolution of approx. 10 μm . The thickness measurements were verified with biofilm models with known thickness and with real biofilms using confocal laser scanning microscopy (CLSM) as independent method (see figure). Additionally, the influence of diverse physico-chemical properties (e.g. flow conditions, pH, suspended particulate matter) on structure and stability of biofilms were investigated. Here, depth-resolved measurements revealed changes in the biofilm structure and allowed the elucidation of the distribution of incorporated particles. An extensive study regarding the reaction of various biocides with biofilms demonstrated the potential of PAS in this field of application. Monitoring of the photoacoustic signal amplitude in the visible spectral range allows the observation of biofilm detachment caused by biocides. Rate and efficiency of the biofilm removal can be determined. In this way, the effects of different biocides and biocide concentrations can be compared with each other. Depth-resolved measurements allow the determination of the biofilm thickness and the elucidation of detachment mechanisms. The outcome was, that hydrogen peroxide allows a very fast and efficient removal of attached biofilms by sloughing off of relatively large areas of the microbial aggregates, whereas no effect on the biofilm matrix was observed in most cases when isothiazolinone biocides were used.

(*T. Schmid*)

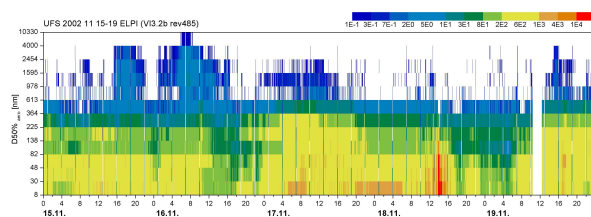
1.6 Aerosol Research

1.6.1 Schneefernerhaus Aerosol and Reactive Nitrogen Experiment (SCAVEX)

Funding: BayStMLU

Cooperation: Vienna University of Technology (Institute of Analytical Chemistry), Paul Scherrer Institute (Atmospheric Chemistry Laboratory), University of Clermont Ferrand (Institute of Physical Meteorology), University of Innsbruck (Institute of Ion Physics), German Aerospace Center (DLR, Institute of Atmospheric Physics), German Weather Service (DWD, Observatory Hohenpeissenberg), Max-Planck-Institute of Nuclear Physics (Institute of Atmospheric Physics)

Thorough physical and chemical characterisation of atmospheric aerosols is required to assess the influence of aerosols on atmospheric chemistry and physics, climate, and human health. In high alpine environments, where both boundary layer and free tropospheric air can be sampled depending on the meteorological conditions, aerosol measurement data are particularly scarce. The SCAVEX project is aimed at the physical and chemical analysis of atmospheric particles at the high alpine Environmental Research Station Schneefernerhaus (UFS) on Mt. Zugspitze. For this purpose a wide range of aerosol measurement and sampling instrumentation have been operated at UFS (CPC, SMPS, ELPI, PM_{2.5}-HV-FS, PASS), and various methods of chemical analysis have been applied to the collected aerosol filter samples, focusing on the determination of total, elemental and organic carbon, polycyclic aromatic hydrocarbons and their nitrated derivatives, proteins and amino acids. A sampler for water vapor condensation nuclei has been developed and characterised.



Depending on the meteorological situation, the observed total particle number concentrations varied typically from a few hundred up to a several thousand particles per cubic centimeter. At low particle concentrations, i.e. under clean conditions such as free tropospheric air, the number size distributions exhibited a maximum in the accumulation mode (particle diameter ≈ 100 nm). At high particle concentrations different size distribution patterns were observed, on some occasions a strong nucleation mode (particle diameter < 30 nm) dominated the total number concentration, in others also the accumulation mode was enhanced. An example for the high variability of aerosol particle number concentration and size distribution is shown in the attached figure, including a couple of Sahara dust events (local maxima at 1000-3000 nm on 15 and 16 November 2002).

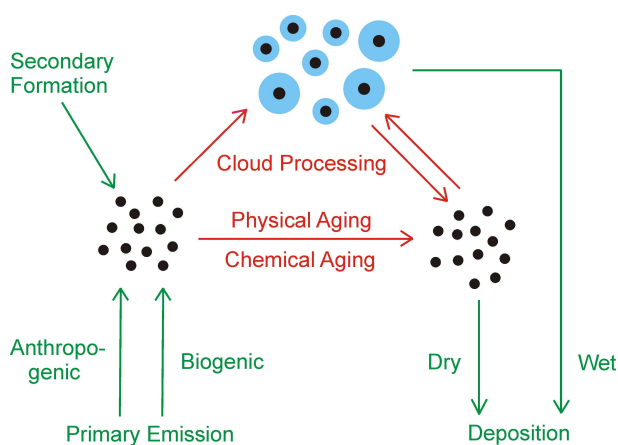
Also the mass concentration and chemical composition of air particulate matter sampled on filters exhibited a high variability and pronounced seasonal trends. For the first time nitrated polycyclic aromatic hydrocarbons have been detected in a high alpine clean air environment, and proteins have been found to account for a large fraction of organic air particulate matter. A detailed interpretation of the aerosol measurement results in combination with trace gas and meteorological data is under way. First results have been presented in several conference contributions and journal articles, and further publications are in preparation.

(S. Bhowmik, T. Fehrenbach, A. Messerer, A. Zerrath)

1.6.2 Carbonaceous Aerosol Components: Chemical Composition, Reactivity and Hygroscopicity (CARBAERO)

Funding: BMBF AFO 2000 07ATC05

The influence of aerosols on atmospheric chemistry and physics, climate, and human health is one of the central topics in today's environmental research. Aerosol particles can scatter or absorb radiation, influence the formation of clouds and precipitation, and affect the abundance of trace gases via heterogeneous chemical reactions and other multiphase processes. Moreover, they can cause respiratory and cardiovascular diseases when deposited in the human respiratory tract.



The environmental and health effects of aerosols are primarily determined by particle number concentration, size distribution, structure, and chemical composition. Numerous studies have shown that carbonaceous components are major constituents of tropospheric aerosols (10-50 % mass fraction), that black carbon is the main light absorber in air particulate matter, and that organics can strongly affect the physicochemical particle properties. The actual composition of atmospheric particles is, however, spatially and temporally highly variable, and the abundance and physicochemical properties of carbonaceous components have been characterized only sparsely and incompletely up to now.

Therefore the central aim of the CARBAERO project is to characterize the molecular structures and abundances, reactivity and water vapor interactions of carbonaceous aerosol components. The investigations are focused on aromatic compounds, macromolecules (biopolymers and humic-like substances), and elemental carbon.

In the year 2003 research activities have been pursued and scientific results have been achieved in the following areas:

- Physical and chemical characterisation of atmospheric aerosols by field measurements at urban, rural, and alpine locations (metropolitan area of Munich, Meteorological Observatory Hohenpeißenberg, Environmental Research Station Schneefernerhaus/Zugspitze).
- Development of measurement techniques for elemental carbon, nitrogen, and organics in air particulate matter (PM), focusing on biopolymers, polycyclic aromatics, humic- and graphite-like substances.
- Laboratory and field experiments on the interaction of aerosol particles with reactive trace gases, focusing on adsorption and surface reactions (kinetics and products) of the substances named above with ozone and nitrogen oxides.
- Laboratory experiments on the interaction of aerosol particles with water vapor and clouds (microstructural rearrangement, hygroscopic growth and droplet formation, activation of cloud condensation nuclei).
- Data analysis and mathematical modeling: determination of basic physicochemical parameters, detailed mechanisms, and simplified parameterisations for the

description of heterogeneous aerosol processes (mass transport, chemical reactions, phase transitions); comprehensive analysis and interpretation of particle, trace gas, and meteorological measurement data.

The results have been presented and discussed in several conference contributions and journal articles, and further publications are in preparation.

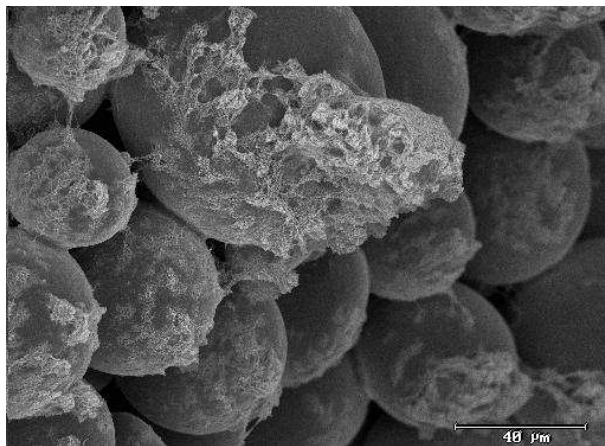
(*S. Bhowmik, T. Fehrenbach, T. Franze, E. Mikhailov, U. Schaller, C. Schauer, A. Zerrath*)

1.6.3 Development of a Filterless Catalytic System for the Continuous Oxidation of Soot Particles for Heavy Duty Vehicles (PM-KAT)

Funding: Bayer. Forschungstiftung

Cooperation: MAN Nutzfahrzeuge AG, Nürnberg; Oberland-Mangold, Garmisch-Partenkirchen; Fritz-Haber-Institute, Department of Inorganic Chemistry, Berlin; Max-Planck-Institute for Polymer Research, Mainz.

Since conventional soot particle filter systems significantly increase exhaust gas back pressure and are easily clogged by engine oil ashes, current research activities are focused on the development of filterless soot particle deposition structures. First results confirm the high potential of newly developed structures for efficient particle deposition. Detailed studies of the involved processes including thermophoresis are under way and will be used to optimize the design and operating conditions. The reaction kinetics and mechanisms of soot particle oxidation by nitrogen oxides and oxygen are also investigated for different deposition structures and types of soot under a wide range of experimental conditions relevant for modern diesel engine exhaust systems.



For the investigation of soot particle deposition and oxidation a test gas bench with specially designed flat bed reactors has been constructed. With a cross section of 10 x 6 mm these reactors can be flexibly equipped with different types of deposition structures (max. length 290 mm). The system can be operated at temperatures up to 450°C with variable gas composition and space velocities of 10000-400000/h. Model soot aerosols are produced with a spark discharge generator (graphite electrodes) or with a modified LaMer-Sinclair generator (polycyclic aromatic hydrocarbons, e.g. hexabenzocoronene). Aerosol particle number size distributions before and after the deposition device are measured with an scanning mobility particle sizer (SMPS) system consisting of an electrostatic classifier and a condensation particle counter (CPC). Sophisticated temperature control devices have been implemented to ensure isothermal sampling conditions at all sampling points and to minimize potential measurement artefacts due to thermophoretic sampling losses.

Numerous catalyst structures have been characterized with respect to transient and stationary particle deposition efficiencies under varying flow and temperature conditions, and particularly efficient deposition was observed for steel-structures coated with microspheres (50 to 150 μm diameters, see Figure). Thermophoretic deposition processes have been investigated with a plate precipitator and a miniature pipe bundle heat exchanger. The experiments are accompanied by numerical modelling of the flow and deposition processes, and by engine test bench measurements

The reaction products and kinetics of the oxidation and volatilisation of deposited soot particles (real diesel soot, spark discharge soot, hexabenzocoronene) by nitrogen oxides and oxygen have been characterised for a wide range of conditions (temperature, gas composition, space velocity), using FTIR spectroscopy and complementary analytical techniques. A detailed analysis and mechanistic interpretation of the measurement results as well as complementary experiments and model calculations are under way. First results have been presented in several conference contributions and journal articles, and further publications are in preparation.
(*C. Adelhelm, E. Dronia, A. Messerer, D. Rothe, A. Thalhammer*)

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- E. Rosenberg and U. Panne (2003); Atomic Absorption Spectrometry (AAS) and Atomic Emission Spectrometry (AES). in: *Handbook of Spectroscopy*, G. Gauglitz, T. Vo-Dinh (Eds) Wiley-VCH 421496.
- T. Schmid, U. Panne, C. Haisch and R. Niessner (2003); Biofilm Monitoring by Photoacoustic Spectroscopy. in: *Biofilms in Medicine, Industry and Environmental Biotechnology* V. O'Flaherty, P. Lens, T. Mahony, A. Moran, P. Stoodley (Eds.) IWA Publishing 443449.

2.3 Conference Presentations

2.3.1 Oral Presentations

- T. Baumann, N. Nestle, R. Niessner, Quantifizierung dynamischer Prozesse in porösen Medien mit Hilfe der Kernspintomographie, Wasserchem. Ges., 28.-30.5.2003, Stade.
- T. Baumann, N. Nestle, Column experiments - Artefacts in Pure Culture?, 3rd Workshop on Environmental Analytical Artefacts, 16.-17.6.2003, Munich.
- P. Degelmann, Q.-Z. Zhu, M. Schedl, D. Knopp, R. Niessner, Enrichment and Analysis of Sulfonylurea Herbicides using Sol-Gel-Generated Immunoaffinity Columns (SGG-IAC) and Molecularly Imprinted Polymers (MIPs), 13. Doktoranden-Seminar, 12.-14. 1. 2003, Kloster Banz
- H. Hetzelt, R. Dietrich, M. Weller, E. Märtlbauer: Entwicklung eines Biosensors zum Nachweis von Bakterien und mikrobiellen Toxinen, Medizinische B-Schutz-Tagung, 30.10.2003, München
- R. Klein, T. Baumann, R. Niessner, Heating Processes in MSWI Bottom Ash, 18th Intern. Conf. Solid Waste Technol. Managem., 23.-26.3.2003, Philadelphia, U.S.A.
- B. Knecht, A. Strasser, R. Dietrich, R. Niessner, E. Märtlbauer, M. G. Weller: Chip-basierter Immunosensor für den schnellen und automatisierten Nachweis von Antibiotika in Milch, 3. BioSensorSymposium, 30.3.-1.4.2003, Potsdam
- B. Knecht, A. Strasser, R. Dietrich, R. Niessner, E. Märtlbauer, M. G. Weller: Development of a Microarray for the Rapid Parallel Detection of Antibiotics in Milk, VIIth International Conference on Agri-Food Antibodies, 10.-13.9.2003, Uppsala, Schweden.
- A. Messerer, D. Rothe, E. Jacob, C. Knab, U. Pöschl, R. Niessner, Soot Particle Deposition and Oxidation in Novel Catalyst Structures, 7th International ETH-Conference on Combustion Generated Nanoparticles, 18.8-20.8.2003, Zürich, Schweiz.
- N. Nestle, A. Wunderlich, R. Niessner, T. Baumann, MRI Studies on Subsurface Transport Processes in Environmental Science: Results, Agenda and Needs for Studies at Higher Spatial Resolution, EUCHEM Conference: Structure and Molecular Mobility in Heterogeneous Systems, 27.-29.8.2003, Fiskebäckskil, Schweden.
- N. Nestle, T. Baumann, A. Wunderlich, R. Niessner, MRI as an Innovative Tool for Studying Subsurface Transport Processes in Environmental Science, XI AMPERE Summer School, 1.-6.6.2003, Zakopane, Polen.
- R. Niessner, A. Messerer, D. Rothe, U. Pöschl, Soot Particle Deposition and Oxidation Under Experimental Conditions Relevant for Modern Diesel Engine Exhaust Systems, European Aerosol Conference 2003, 31.8.-5.9.2003, Madrid, Spanien.
- U. Panne, I. Radivojevic, C. Haisch, R. Niessner, H. Becker-Ross, S. Florek, Laser-Induced Plasma Spectroscopy (LIPS) in the VUV - Possibilities and Limitations, CLEO/Europe-EQEC, 2003, 23.06-26.06.2003, München.
- U. Pöschl, Y. Rudich, M. Ammann, Kinetic Model Framework for Aerosol Surface Chemistry and Gas-Particle Interactions, EGS-AGU-EUG Joint Assembly 2003, 6.4.-11.4.2003, Nice, Frankreich.
- U. Pöschl, T. Franze, E. Mikhailov, U. Schaller, C. Schauer, A. Zerrath, Carbonaceous Components of Atmospheric Aerosols: Chemical Composition, Reactivity, and Water Vapor Interactions, European Aerosol Conference 2003, 31.8.-5.9.2003, Madrid, Spanien.

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- H. Prestel, T. Schmid, C. Helmbrecht, R. Nießner, U. Panne, Untersuchung des kolloidalen Stofftransports in biologischen Kläranlagen mittels AF4 und ICP-MS, Wasserchemische Gesellschaft, 26.05-28.05.2003, Stade.
- H. Prestel, T. Schmid, C. Helmbrecht, R. Nießner, U. Panne, Untersuchung des kolloidalen Stofftransports in biologischen Kläranlagen mittels AF4 und ICP-MS, Wasserchemische Gesellschaft, 26.05-28.05.2003, Stade.
- A. Strasser, R. Dietrich, E. Märtlbauer M. Weller, B. Knecht, R. Niessner: Entwicklung eines Biosensors zum Nachweis von Antiinfektiva in Milch, 44. Tagung des Arbeitsgebietes Lebensmittelhygiene der Deutschen Veterinärmedizinischen Gesellschaft e.V. (DVG), 29.9.-2.10.2003, Garmisch-Partenkirchen
- M. G. Weller, I. Schaupt, M. Kiening, A. Zeck, R. Niessner: Immunological and Mass-Spectrometrical Methods for the Control of Algal Toxin Contaminations in Drinking Water, Achema, 20.5.2003, Frankfurt am Main.
- S. Wurzler, H. Herrmann, R. Wolke, U. Pöschl, O. Möhler, U. Schurath, AFO2000 Multiphase Processes, EGS-AGU-EUG Joint Assembly 2003, 6.4.-11.4.2003, Nice, Frankreich.

2.3.2 Poster Presentations

- M. Alte, R. Niessner, T. Baumann, Ein faseroptischer MIR-Sensor zur räumlichen und zeitlichen Erfassung von VOC in Wasser, Wasserchemische Gesellschaft, 28.-30.5.2003, Stade.
- T. Baumann, P. Fruhstorfer, T. Klein, R. Niessner, Colloids in the Vicinity of Landfills, EGS/EGU/AGU Joint Assembly, 6.-11.4.2003, Nice, Frankreich.
- T. Baumann, O. Fenton, B. Past, A. Deng, D. Knopp, R. Niessner, Hochdurchsatzfähige Bestimmung von Sorptionsparametern im Mikrotiterplattenformat, Wasserchem. Ges., 28.-30.5.2003, Stade.
- R. Biber, R. Niessner, T. Baumann, Statistische Methodenkombination zur Abschätzung der Verlässlichkeit von Elutionsverfahren im Rahmen der Sickerwasserprognose, Wasserchemische Gesellschaft, 28.-30.5.2003, Stade.
- A. Deng, M. Himmelsbach, Q.-Z. Zhu, M. Sengl, S. Frey, R. Niessner, W. Buchberger, D. Knopp; Entwicklung und Anwendung eines ELISA für den Arzneimittelwirkstoff Diclofenac; ANAKON 2003, 2.-5. 4. 2003, Konstanz
- M. Gründig, M. Richter, A. Seese, N. Nestle, T. Baumann, Spatial Distribution of Heterogeneous Water Flow and Heavy Metal Transport in Soil Columns, ConSoil 2003, 12.-16.3.2003, Gent, Belgien.
- T. Franze, K. Krause, R. Niessner, U. Pöschl, Proteins and Amino Acids in Air Particulate Matter, European Aerosol Conference 2003, 31.8.-5.9.2003, Madrid, Spanien.
- N. Hock, H. Berresheim, S. Borrmann, U. Pöschl, A. Roempp, J. Schneider, The Hohenpeissenberg Aerosol Characterization Experiment (HAZE 2002): Aerosol Composition Derived from Mass Spectrometry, EGS-AGU-EUG Joint Assembly 2003, 6.4.-11.4.2003, Nice, Frankreich.
- M. Kiening, R. Nießner, M. G. Weller, Entwicklung von Schnelltests zur Bestimmung von Spuren von Nahrungsmittelallergenen in Lebensmitteln, DECHEMA-Jahrestagung der Biotechnologen, 2.-4.4 2003, Garching

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- M. Kiening, R. Nießner, M. G. Weller, Immunoanalytische Schnellmethoden für den Spurennachweis von Erdnuss- und Haselnussproteinen in Lebensmitteln, BioSensorSymposium, 30.3.-2.4.2003, Potsdam
- M. Kiening, R. Niessner, M. G. Weller, Investigations on Screening Methods for the Development of Immunoassays for the Detection of Food Allergens, Conference on Agri-Food Antibodies, 10.-13.9.2003, Uppsala, Schweden
- B. Knecht, A. Strasser, R. Dietrich, E. Märtlbauer, R. Nießner and M. G. Weller: Development of a Biosensor for the Rapid Detection of Antibiotics in Milk, Dechema-Jahrestagung der Biotechnologen, 2.-4.4.2003, Garching
- B. Knecht, A. Strasser, R. Dietrich, R. Niessner, E. Märtlbauer, M. G. Weller: Development of a Biosensor for the Rapid Detection of Antibiotics in Milk, Forschung live, Wissenschaft in Garching, Tag der offenen Tür, 25.10.2003, Garching
- A. Messerer, R. Niessner, U. Pöschl, Laboratory Studies of Thermophoretic Deposition for the Reduction of Diesel Particulate Emissions, European Aerosol Conference 2003, 31.8.-5.9.2003, Madrid, Spanien.
- A. Messerer, D. Rothe, U. Pöschl, R. Niessner, Advances in the Development of Filterless Soot Deposition Systems for the Continuous Removal of Diesel Particulate Matter, 6th International Congress on Catalysis and Automotive Pollution Control, 22.10.-24.10.2003, Brussels, Belgien.
- E. Mikhailov, S. Vlasenko, R. Niessner, U. Pöschl, Interaction of Aerosol Particles Composed of Protein and Inorganic Salts with Water Vapor: Hygroscopic Growth and Microstructural Rearrangement, European Aerosol Conference 2003, 31.8.-5.9.2003, Madrid, Spanien.
- N. Nestle, R. Niessner, T. Baumann, Direct Observation of Alcohol Flooding Processes in Sandy Sediments, EGS/EGU/AGU Joint Assembly, 6.-11.4.2003, Nice, Frankreich.
- H. Prestel, T. Schmid, C. Helmbrecht, R. Niessner, U. Panne, Untersuchung des kolloidalen Stofftransports in biologischen Kläranlagen mittels AF⁴ und ICP-MS, ANAKON 2003, 02.0405.04.2003, Konstanz.
- I. Radivojevic, R. Niessner, U. Panne, Analysis of Coal by Single Pulse Laser Induced Plasma Spectroscopy, ANAKON 2003, 02.0405.04.2003, Konstanz.
- I. Radivojevic, C. Haisch; R. Niessner, U. Panne, Detection of Bromine in Recycled Thermoplasts from Consumer Electronics by Laser-induced Plasma Spectroscopy, ANAKON 2003, 02.0405.04.2003, Konstanz.
- I. Radivojevic, C. Haisch; R. Niessner, H. Becker-Ross, S. Florek, U. Panne, Development of a System for Laser-Induced Plasma Spectroscopy in the VUV, ANAKON 2003, 02.0405.04.2003, Konstanz.
- S. Rojas, L. Gomes, P. Laj, J.-F. Fournol, A. Marinoni, K. Desboeufs, D. Orsini, A. Messerer, U. Pöschl, Experimental Studies of CN/CCN Interactions at Zugspitze during SCAVEX, European Aerosol Conference 2003, 31.8.-5.9.2003, Madrid.
- D. Rothe, A. Messerer, E. Jacob, R. Niessner, U. Pöschl, Laboratory Studies of Soot Oxidation and Volatilisation by Nitrogen Oxides Under Realistic Diesel Engine Exhaust Gas Conditions, European Aerosol Conference 2003, 31.8.-5.9.2003, Madrid, Spanien.

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- D. Rothe, A. Messerer, C. Adelhelm, E. Jacob, R. Niessner, U. Pöschl, R. Schlögl, D. Su, J.-O. Mueller, K. Muellen, C. Simpson, Z. Tomovic, Physical and Chemical Characterisation of Model Soot Aerosol Particles and Real Diesel Engine Exhaust Particles, European Aerosol Conference 2003, 31.8.-5.9.2003, Madrid, Spanien.
- U. Schaller, T. Franze, A. Zerrath, T. Feherenbach, R. Niessner, U. Pöschl, Analysis of Biopolymers and Humic-Like Substances in Atmospheric Aerosols, ANAKON 2003, Konstanz, 2.4.-5.4.2003.
- U. Schaller, A. Zerrath, R. Niessner, U. Pöschl, Analysis of Carbohydrates, Humic-Like Substances and Elemental Carbon in Air Particulate Matter, European Aerosol Conference 2003, 31.8.-5.9.2003, Madrid, Spanien.
- C. Schauer, R. Niessner, U. Pöschl, Analysis of Polycyclic Aromatic Hydrocarbons (PAH) and Nitro-PAH in Urban, Rural, and Alpine Aerosol Samples: Methods, Results, and Sampling Artefacts, ANAKON 2003, 2.4.-5.4.2003, Konstanz.
- C. Schauer, R. Niessner, U. Pöschl, Polycyclic Aromatic Hydrocarbons (PAH) and Nitro-PAH in Urban, Rural, and Alpine Aerosols: Local Differences, Decadal and Seasonal Trends, and Sampling Artefacts, European Aerosol Conference 2003, 31.8.-5.9.2003, Madrid, Spanien.
- C. Schauer, R. Niessner, U. Pöschl, Chemical Reactivity of Polycyclic Aromatic Hydrocarbons on Aerosol Particles: Field Measurements and Laboratory Experiments, European Aerosol Conference 2003, 31.8.-5.9.2003, Madrid, Spanien.
- I. Schaupt, C. Haskard, R. Nießner, M. G. Weller: Immunologische Methoden zum Nachweis von cyanobakteriellen Hepatotoxinen, Dechema-Jahrestagung der Biotechnologen, 2.-4.4. 2003, Garching.
- I. Schaupt, R. Niessner, M. G. Weller: Immunoaffinitätsanreicherung als Cleanup für die Massenspektrometrie zur Bestimmung von Microcystinen in Trink- und Oberflächenwasser, Jahrestagung der Wasserchemischen Gesellschaft, 26.-28.5.2003, Stade.
- T. Schmid, U. Panne, C. Haisch, R. Niessner, Online Monitoring von Biofilmen mittels photoakustischer Spektroskopie, ANAKON 2003, 02.0405.04.2003, Konstanz.
- T. Schmid, C. Helmbrecht, U. Panne, C. Haisch, R. Niessner, Online-Analytik opaker Flüssigkeiten mittels photoakustischer Spektroskopie, ANAKON 2003, 2.-5.4.2003, Konstanz.
- T. Schmid, U. Panne, C. Haisch, R. Nießner, Online-Monitoring von Biofilmen mittels photoakustischer Spektroskopie, Jahrestagung der Wasserchemischen Gesellschaft 2003, 26.-28.5. 2003, Stade.
- D. Spangenberg, R. Niessner, T. Baumann, Reduzierung der Arsenbelastung in Wasserwerksrückständen mittels elektrokinetischer Methoden, Sanierung von Arsen-Kontaminationen in Böden, Grund- und Oberflächenwässern, 21.-22.10.2003, Leipzig.
- A. Zerrath, R. Niessner, U. Pöschl, Physical and Chemical Characterisation of Atmospheric Aerosols with an Electrical Low Pressure Impactor, European Aerosol Conference 2003, Madrid, 31.8.-5.9.2003.

2.3.3 Invited Lectures

- D. Knopp, Pharmaceuticals in the Environment: Analysis of Diclofenac using ELISA and GC-MS; IMA '03 (3rd International Conference Instrumental Methods of Analysis, Modern Trends and Applications), 23.-27. 9. 2003, Thessaloniki, Greece

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- R. Nießner, Laser Photoacoustic Characterization of a Living Tissue-Biofilm. 08.9.03, 33. Colloquium Spectroscopicum Internationale, Granada, Spanien
- R. Nießner, Analytische Chemie: Eine alle Disziplinen umfassende Wissenschaft? 08.10.2003, GDCh-Jahrestagung Chemie 2003, München
- R. Nießner, Removal and Monitoring of Diesel Soot Emission: New Routes 10.11.2003, 1st Intern. Symposium on Incomplete Combustion, Kuopio, Finnland
- R. Nießner, Lasers or Antibodies: Strong Partners for the Analyst. 19.11.03, Universität Genf
- R. Nießner, Immuno-chip Technologies for Rapid Determination of Allergen and Antibiotics. 02.12.2003, 2nd Asian-pacific International Conference on Pollutants Analysis and Control, HoChiMinh City, Vietnam
- R. Nießner, Potentiale der Laser-Photoakustik für die Multi-Komponenten-Abgasanalyse. 08.12.2003, FVV-Workshop "Laserbasierte Abgasmeßtechnik für die Zukunft", Frankfurt
- R. Nießner, Trends und Herausforderungen der Analytischen Chemie. 15.12.03, GSF Neuherberg
- U. Panne, Photonics-Schlüsseltechnologie für die Analytik, Institut für Anorganische Chemie und Analytische Chemie, Johannes Gutenberg-Universität, 21.01.2003, Mainz, Germany.
- U. Panne, Ray Guns and More - Prospects of Lasers in Spectrochemical Analysis, Center of Excellence in Analytical Chemistry (CEAC), ETHZ, 23.01.2003, Zürich, Switzerland.
- U. Panne, Schlüsseltechnologien für die Analytik, Institut für Anorganische Chemie und Analytische Chemie, Westfälische-Wilhelms-Universität Münster, 08.05.2003, Münster, Germany.
- U. Panne, Photonics- eine Schlüsseltechnologie für die Chemische Analytik, TU Darmstadt, FB Material- und Geowissenschaften, 06.06.2003, Darmstadt, Germany.
- U. Panne, Photonics- eine Schlüsseltechnologie für die Chemische Analytik, Universität Leipzig, Fakultät für Chemie und Mineralogie, 24.07.2003, Leipzig, Germany.
- U. Panne, Photonics- eine Schlüsseltechnologie für die moderne Analytische Chemie, Humboldt Universität zu Berlin, 29.10.2003, Berlin.
- U. Pöschl, Troposphärische Aerosole: Partikeleigenschaften und Wechselwirkungen mit Wasserdampf und Wolken, Institut für Meteorologie, Universität München, 30.1.2003.
- U. Pöschl, Troposphärische Aerosole: Partikeleigenschaften, Oberflächenreaktionen und Wechselwirkung mit Wasserdampf, Institut für Chemie und Dynamik der Geosphäre (ICG II), Forschungszentrum Jülich, 15.5.2003.
- U. Pöschl, Struktur und Reaktivität von Aerosolpartikeln, Institut für Materialchemie, Technische Universität Wien, 13.6.2003.
- U. Pöschl, Outdoor Air ELPI Measurements of Urban, Rural, and High-Alpine Aerosols, Dekati Ltd., ELPI Workshop 2003, Tampere, 1.7.2003.
- U. Pöschl, Interactive Journal Concept for Future Scientific Quality Assurance, MPG Open Access Conference, Harnack Haus d. Max-Planck-Gesellschaft, Berlin, 21.10.2003.

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- U. Pöschl, Composition and Transformation of Atmospheric and Combustion Aerosol Particles, Institute for Environment and Sustainability, EC Joint Research Center, Ispra, 7.11.2003.
- U. Pöschl, Chemical Composition and Reactivity of Organic Aerosol Components, Institut für Inhalationsbiologie, GSF-Forschungszentrum, München, 25.11.2003.
- M. G. Weller, Analytik von cyanobakteriellen Toxinen, Engler-Bunte-Institut, Lehrstuhl für Wasserchemie, Universität Karlsruhe, Wasserchemisches und -technologisches Kolloquium, 12.12.2003, Karlsruhe
- M. G. Weller, Biosensoren für die wirkungsbezogene Analytik, GDCh-Jahrestagung, 8.10.2003, München
- M. G. Weller, Multidimensional Analysis of Cyanobacterial Toxins, Second Late Summer Workshop "Monitoring Toxic Effects in Aquatic Systems", 30.9.2003, Schloss Maurach

2.3.4 Scientific Committee

- R. Nießner, Second Late Summer Workshop "Monitoring Toxic Effects in Aquatic Systems", 30.9.2003, Schloss Maurach
- R. Nießner, 3rd Workshop on Environmental Analytical Artefacts, 16.-17.6.2003 München.

2.4 Hydrogeological Consulting

- Mineralisation control analyses* Bad Abbach, Bayreuth, Bad Birnbach, Bad Endorf, Bad Füssing, Bad Griesbach, Bad Gögging, München, Bad Rodach, Sybillenbad, Staffelstein, Straubing, Bad Tölz, Utting, Bad Wiessee, Bad Wimpfen
- Hydrogeological and hydrochemical expertises (mineral water, spa water)* Bad Gögging, Bad Brückenau, Hölle, Sibyllenbad, Siegsdorf.

2.5 Bachelor and Diploma Theses

- Martina Landmann: Aufreinigung und Lagerungsversuche mit dem monoklonalen Antikörper AD 4 G 2 (Bachelor)
- Sebastian Egger: Herstellung und Charakterisierung von Sol-Gel-Glas-Coatings an porösen Silikatträgern (Staatsexamen)
- Elisabeth Dronia: Experimentelle Untersuchungen zur simultanen Rußpartikeldeposition und -oxidation unter relevanten Betriebsbedingungen für Nutzfahrzeugabgassysteme (Dipl.-Ing.)
- Christoph Adelhelm: Erzeugung, Charakterisierung und Oxidation ultrafeiner HBC-Aerosolpartikel (Dipl.-Chem.)

2.6 PhD Theses

- Dipl.-Chem. Barbara Fall: Entwicklung eines chemilumineszenzbasierten Microarrays zur Detektion von allergenspezifischem IgE
- Dipl.-Biol. Thomas Meindl: Biochemische und physiologische Reaktionen von inflammatorischen Zellen auf feine/ultrafeine Teilchen

Dipl.-Chem. Harald Beck: Anwendung der Photoakustischen Spektroskopie in der Prozess- und Umweltanalytik

Dipl.-Chem. Thomas Schmid: Laserinduzierte photoakustische Spektroskopie als Sensorprinzip: Anwendungen in der Prozess- und Umweltanalytik

3 Teaching, Colloquia, and Other Activities

3.1 Classes

Chemie gelöster und ungelöster Wasserinhaltsstoffe, Teil 1: Wasserkreislauf und Gleichgewichte	Nießner
Chemie gelöster und ungelöster Wasserinhaltsstoffe, Teil 2: Hydrokolloide, micellare Systeme und photochemische Umsetzungen	Nießner
Organische Spurenanalytik für Geowissenschaftler	Nießner
Spurenanalytische Techniken	Nießner
Umweltanalytik, Teil 1: Grundlagen der instrumentellen Analytik von Wasserinhaltsstoffen	Nießner
Umweltanalytik, Teil 2: Charakterisierung von Luftinhaltsstoffen (Gase und Aerosole)	Nießner
Umweltanalytik, Teil 3: Organische Spurenanalytik an Umweltmatrices	Nießner
Water Chemistry (GIST Singapur)	Nießner
Massenspektrometrie in der Umweltanalytik	Weller, Nießner
Biochemische und molekularbiologische Analysenverfahren in der Umweltanalytik	Knopp
Einführung in das hydrogeologische Praktikum I, II, III	Baumann, Nießner
Hydrogeologie I und II	Baumann
Ausbreitung von Schadstoffen im Untergrund	Baumann
Erkundung und Sanierung von Grundwasserschadensfällen	Baumann
Modellierung der Grundwasserströmung und des Stofftransports	Baumann
Hydrochemische Modellierung	Baumann
Chemie und Technologie des Trink- und Betriebswassers I (Wasser und Umwelt)	Knopp
Ringvorlesung "Biochemische Analytik"	Knopp u.a.
Chemische Charakterisierung von Umweltmatrices (Gase)	Nießner
Statistische Methoden in der Umweltanalytik	Panne
Umweltmeßtechnik mit spektroskopischen Methoden	Panne
Analytische Methoden für Gase und Aerosole	Pöschl
Gasmestechnik	Pöschl
Atmosphärenchemie und Klimaforschung (TU Wien)	Pöschl

3.2 Lab Courses and Seminars

Vertiefungsfach Analytische Chemie, Teil 1 Organische Spurenanalytik	Nießner, Weller, Panne
Teil 2 Methoden der Strukturaufklärung und Instrumentellen Analytik	Nießner und Mitarbeiter, Dozenten in Garching
Wasserchemisches Praktikum I: Wasseranalyse	Panne, Weller, Nießner
Wasserchemisches Praktikum II: Wassertechnologie	Panne, Nießner
Praktikum Umweltmesstechnik	Pöschl, Nießner
Hydrogeologisches Praktikum I: Gesteinsphysikalische Methoden	Baumann, Nießner
Hydrogeologisches Praktikum II: Hydrochemische Methoden	Baumann, Nießner
Hydrogeologisches Praktikum III: Geländeübungen mit Kurs	Baumann, Nießner
Hydrogeologische und hydrochemische Exkursionen	Baumann, Nießner
Hydrogeologisches, hydrochemisches und umweltanalytisches Seminar	Baumann, Nießner

3.3 Institute Colloquia

- Prof. Dr. Marja-Liisa Riekkola, Laboratory of Analytical Chemistry, Department of Chemistry, University of Helsinki: Potential of Novel Separation Methods in the Analysis of Organic Compounds in Aerosol Particles (15.1.2003)
- Prof. Dr. Karl Molt, Institut für Chemie, Instrumentelle Analytik, Universität Duisburg-Essen: IR/NIR/Raman als Methoden der betriebsnahen Analytik und Prozesskontrolle - ein Vergleich (22.1.2003)
- Dr. Norbert Jakubowski, Institut für Spektrochemie und Angewandte Spektroskopie, Dortmund: Analyse von Biomolekülen mittels ICP-MS: Eine neue Herausforderung? (18.2.2003)
- Prof. Dr. H. Parlar, Lehrstuhl für Chemisch-technische Analyse, TU München-Weihenstephan: Isoelektrisch fokussierte Zerschäumungsanalyse (26.2.2003)
- Prof. Dr. Carla Vogt, Institut für Anorganische Chemie, Universität Hannover: Mikrobereichsanalyse fester Proben / Surface Analysis of Solid Samples (11.3.2003)
- Dr. Fritz Keilmann, Max-Planck-Institut für Biochemie, Abt. Molekulare Strukturbiologie, Martinsried: Nahfeldmikroskopie im Infraroten (7.4.2003)
- Prof. Dr. Franz L. Dickert, Lehrstuhl für Analytische Chemie, Universität Wien: Synthetic Receptors as Sensor Coatings für Large Molecules and Living Cells, (14.4.2003)
- Dr. Mark Rehkämper, Institute of Isotope Geology & Mineral Resources, ETH Zürich: Heavy Elements as Stable Isotope Tracers - New MC-ICPMS Techniques for the Measurement of Mass-dependent Stable Isotope Variations and their Application in Geochemistry (19.5.2003)
- Prof. Dr. Günther Bonn, Institut für Analytische und Radiochemie, Universität Innsbruck: Phytoanalytik - Eine Herausforderung in Phytomics (4.6.2003)
- PD Dr. Gerhard J. Mohr, Institute of Physical Chemistry, Friedrich-Schiller-University Jena: Chromogenic and Fluorogenic Reactands in Analytical Chemistry (5.6.2003)

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- PD Dr. Thorsten Hoffmann, Institut für Spektrochemie und Angewandte Spektroskopie, Dortmund: Entwicklung und Optimierung von Atmosphärendruck-Ionenquellen für die on-line Analytik von umweltrelevanten und biologischen Matrices (12.6.2003)
- Prof. Dr. Guenther Paltauf, Institut für Experimentalphysik, Karl-Franzens-Universität Graz: Optoakustische Tomographie von biologischem Gewebe (27.6.2003)
- a.o. Prof. Dipl.-Ing. Dr.techn. Bernhard Lendl, Institut für Chem. Technologien und Analytik, TU Wien: Infrarot und Ramanspektroskopie für die Analytische Chemie: Neue Konzepte und deren Anwendungen (16.7.2003)
- Prof. Dr. K. Kohse-Hoeinghaus, Physikalische Chemie I, Universität Bielefeld: Quantitative Combustion Diagnostics: Studying Detailed Flame Chemistry (24.9.2003)
- Prof. Dr. Edward S. Yeung, Ames Laboratory, Iowa State University, USA: High Throughput Chemical and Biochemical Measurements (8.10.2003)
- Prof. Dr. Dieter Naumann, Biophysical Structure Analysis, Robert Koch Institute, Berlin: Charakterisierung von Mikroorganismen mittels Fourier-Transform-Infrarotspektroskopie und Verfahren der Mustererkennung (22.10.2003)
- Prof. Dr. Sergei A. Eremin, M.V. Lomonosov Moscow State University, Department of Chemical Enzymology, Faculty of Chemistry: Fast Monitoring of Environmental Contaminants and Drugs (7.11.2003)
- Prof. Dr. Christoph Bräuchle, Lehrstuhl Physikalische Chemie I, Ludwigs-Maximilians-Universität München: Optische Experimente mit einzelnen Molekülen in Bio- und Nanowissenschaften - Analytik an der Nachweisgrenze (13.11.2003)
- Prof. Dr.-Ing. Dirk Weuster-Botz, Lehrstuhl für Bioverfahrenstechnik, TU München: Kontrolle von Bioreaktoren - noch immer eine Herausforderung (27.11.2003)
- PD Dr. Thomas Ternes, Bundesanstalt für Gewässerkunde, Koblenz: Moderne instrumentelle Analytik: Der Schlüssel zum Verständnis des Umweltverhaltens von Arzneimitteln (10.12.2003)

3.4 External Tasks and Memberships

Prof. Dr. Reinhard Nießner

BayFORUV	Board of Directors (until 12/2003)
BayFORREST	Member
Fachbereich IV Meßtechnik der VDI/DIN-Kommission Reinhaltung der Luft	Advisory Board Member (until 12/2003)
Bayer. Fachausschuß für Kurorte, Erholungsorte und Heilbrunnen	Member
DECHEMA Commission "Chemische Grundlagen und Anwendungen der Sensortechnik"	Member (since 11/2002)
DFG-Senatskommission für Wasserforschung	Member (since 11/2002)
Heinrich-Emanuel-Merck-Award	Jury Head
Bayer. Institut für Abfallforschung, Augsburg	Advisory Board Member
Association for Aerosol Research (GAeF)	Board of Directors
Analytical Chemistry	Associated Editor
Analytical and Bioanalytical Chemistry	Advisory Board Member
Microchimica Acta	Advisory Board Member
Fresenius' Environmental Bulletin	Advisory Board Member
Analytical Sciences	Advisory Board Member
Analyst	Advisory Board Member

PD Dr. Dietmar Knopp

BayFORREST	Member
KRdL-3/7/04, "Luftgetragene Mikroorganismen und Viren", im VDI/DIN	Member
Vom Wasser	Editorial Board Member (until 12/2003)

PD Dr. Ulrich Panne

Spectrochimica Acta B	Advisory Board Member
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Dr. Ulrich Pöschl

Atmospheric Chemistry and Physics	Chief Executive Editor
European Geosciences Union	President of Atmospheric Sciences Division, Council Member

4 Equipment

4.1 Hydrogeology

Two pilot scale tanks with flow lengths of up to 10 m allow transport experiments in a controlled environment while preserving almost natural conditions. Apart from studies on the transport behaviour of contaminants and colloids, these facilities are used for testing sensor prototypes and serve as a test bed for numerical models.

Additionally three landfill monitoring sites, one municipal solid waste landfill, one MSWI bottom ash landfill, and one mixed waste landfill are run by the institute.

4.2 Environmental Analytical Chemistry

4.2.1 Laser

- 4 He/Ne-laser
- 6 Nd-YAG-laser
- 1 CO₂-laser
- 3 Dye-laser (tuneable with frequency doubler)
- 5 N₂-laser
- 8 Tuneable diode-lasers (600-1670 nm; ca. 100 mW CW)
- 1 Laser-diode-array with 10 diodes (0.8 μm - 1.8 μm)
- 1 Laserdiode with external resonator
- 1 Optical parameter oscillator (410 nm - 2.1 μm)

4.2.2 Optoelectronics/Spectrometer

- 1 Rowland spectrometer
- 1 Echelle spectrometer
- 1 FTIR-Spectrometer, Perkin Elmer 1600
- 1 Fluorescence spectrometer, Perkin Elmer LS-50
- 1 Fluorescence spectrometer, Shimadzu RF 540
- 1 UV/VIS spectrometer, Beckman DU 650
- 1 Boxcar integrator
- 4 Digital storage oscilloscopes (400 MHz, 500 MHz)
- 3 Optical multichannel analysators with monochromators, time-resolving
- 3 Intensified CCD cameras
- 1 Wavemeter

4.2.3 Chromatography

- 7 GCs with FID, NPD, ECD, TEA and AED
- 1 GC/MS, block-injection and autosampler
- 1 High-resolution GC/MS, VG Autospec
- 1 LC-Orthogonal-ESI-TOF-MS, Micromass
- 1 Lyophilizer
- 1 Asymmetrical Field-flow-fractionation system
- 1 SFE-System with modifier, Suprex
- 2 Concentrators for dynamic headspace analysis
- 1 High-speed counter-current-distribution chromatographic system
- 3 HPLC, UV/VIS array detector, programmable fluorescence detector
- 2 HPLC
- 1 Capillary electrophoresis system
- 1 Ion chromatograph, Dionex 4500 i
- 1 Ion chromatograph, Dionex BioLC (Photodiode Array Detector, Electrochemical Detector)
- 1 AMD system for HPDC with UV, VIS and fluorescence scanner
- 1 LC system, ECONO
- 1 Preparative HPLC

4.2.4 Dioxin Laboratory

- 3 High security labs with locks,
separate activated carbon filter and high-performance particle filter systems

4.2.5 Bioanalytics

- 2 Fluorescence reader systems, time-resolving
- 3 Photometric reader systems
- 1 Chip spotter system, GESIM

4.2.6 Element Analytics

- 1 TXRF, Atomika EXTRA II a
- 1 Flame-Photometer, Eppendorf ELEX 6361
- 2 AAS systems with flame atomization, electrothermal atomization, hydrid system,
Perkin-Elmer PE 3300, ELAN 4100
- 1 ICP-MS, Perkin-Elmer ELAN 6100

4.2.7 SEM/Microscopy

- 1 SEM/EDX system
- 2 Polarisation microscopes for phase analysis
- 1 Image analysis software for automated image processing
- 1 Inert gas glovebox
- 1 Laser Raman microscope, Renishaw (514 nm, 633 nm, 780 nm)
- 1 Zetaphoremeter, SEPHY

4.2.8 Sum Parameters

- 2 Coulostat for C quantification, Coulomat 702
- 1 DOC analysator, UNOR 6 N
- 1 TOC analysator, TOCOR 2
- 1 AOX/TOX, Sigma

4.2.9 Aerosol Research

- 1 Aerosol chamber (1 m³)
- 1 Aerosol flow tube (10 L)
- 1 Ozone analyzer (UV absorption)
- 1 NO/NO₂ analyser (Chemiluminescence)
- 2 Aerodynamic particle sizers (0.5-25 μm)
- 1 Berner impactor (9 stages, 50 nm - 16 μm)
- 1 Electrical low-pressure impactor (12 stages, 30 nm - 10 μm)
- 2 Low-Volume filter samplers (PM 10, PM2.5)
- 1 High-Volume filter sampler (PM 2.5)
- 2 Differential mobility particle sizer systems (10-1000 nm)
- 2 Diffusion batteries (5-300 nm)
- 5 Condensation nucleus counters
- 3 Electrostatic classifiers (10-1000 nm)
- 2 Spark-discharge soot aerosol generators (polydisperse ultrafine carbon aerosol)
- 1 Berglund-Liu aerosol generator (monodisperse aerosols, 0.8-50 μm)
- 1 Floating bed aerosol generator (powder dispersion)
- 1 Rotating brush aerosol generator (powder dispersion)

5 Staff 2003

Univ.-Prof. Dr. Reinhard Nießner

Dr. Thomas Baumann
Dr. Swati Bhowmik
Dr. Christoph Haisch
Dr. Ralf Biber (until 12/03)
PD Dr. Dietmar Knopp
PD Dr. Ulrich Panne
Dr. Ulrich Pöschl
Dr. Harald Prestel
Dr. Thomas Schmid
PD Dr. Michael Weller

Birgit Apel
Günter Dollinger
Roswitha Glunz
Karin Koller
Joachim Langer
Ramona Leube
Susanne Mahler
Christine Sternkopf
Christa Stopp
Sebastian Wiesemann

Hatice Hazir
Mira Kolar

PhD Students

Dipl.-Chem. Christoph Adelhelm (since 9/03)
Dipl.-Geol. Matthias Alte
Dipl.-Chem. Petra Degelmann
Dipl.-Chem. Tobias Fehrenbach (since 3/03)
Dipl.-Chem. Thomas Franze
Dipl.-Leb.Chem. Martin Kiening
Dipl.-Chem. Bertram Knecht
Dipl.-Chem. Susanne Maier (since 3/03)
Dipl.-Chem. Diana Matschulat
Dipl.-Ing. Armin Messerer
Dipl.-Phys. Igor Radivojevic (until 11/03)
Dipl.-Chem. Dieter Rothe (since 9/03)
Dipl.-Chem. Ulrike Schaller
Dipl.-Chem. Christian Schauer (until 9/03)
Dipl.-Leb.Chem. Isabel Schaupt (until 7/03)
Dipl.-Geol. Dagmar Spangenberg
Dipl.-Chem. Axel Zerrath

External PhD Students

Apothekerin Ellen Bitterle (GSF)
Dipl.-Chem. Michael Harris (OMG AG, Hanau)
Dipl.-Biol. Thomas Meindl (GSF, until 3/03)
Dipl.-Biol. Roman Radykewicz (GSF)
Leb.-Chem. Michael Rampfl (IBP Holzkirchen,
since 8/03)

Diploma Students/Masters Thesis

Pooja Bajaj (since 8/03)
Sabine Bräu (since 11/03)
Sovoeunsowath Choengh (until 9/03)
Elisabeth Dronia (until 10/03)
Sebastian Egger (until 11/03)
Josef Fischer (until 1/03)
Martina Landmann (until 6/03)
Christoph Radl (since 8/03)
Maria Taige (since 8/03)
Astrid Thalhammer (since 11/03)

Guests and Research Fellows

Marléne Aupart (6/03 - 8/03)
Dr. Anping Deng, Sichuan University, Chengan/China
Owen Fenton, MSc
Katalin Hajnal, University of Pecs (until 6/03)
Dr. Natalia Ivleva (since 3/03)
Dr. Jiaping Lai, Nanking University, Tian Jin,
China
Dr. Evgene Mikhailov, State University, Peters-
burg/Russia (since 8/03)
Viktorija Ruppa, Forschungsinst. f. Kolloidchemie,
Kiew/Ukraine (until 3/03)
Chiara Vallebona, IPCF-CNR Pisa (5/03 - 7/03)
Lih Ting Voon, National University, Singapore
(until 6/03)
Hong Yang, Sichuan University, Chengan/China
Prof. Dr. Atsushi Yurai, Osaka Sangyo Univer-
sity, Osaka/Japan (until 3/03)

Student Assistants

Dipl.-Biol. Iris Vomberg (since 11/03)
Leb.-Chem. Lucie Schott (since 7/03)
Wei Chen (5/03 - 7/03)
Benjamin Gries (3/03 - 7/03)
Nikola Heimpel (3/03 - 8/03)
Marek Janko (5/03 - 8/03)
Jochen Knefel (until 8/03)
Peter Schock (until 1/03)
Xiang Yu (until 3/03)
Ziller, Martin (until 1/03)