

UNIVERSITY OF DUISBURG-ESSEN:

Information for Applicants for the W3-Professorship

Physical chemistry of liquid/solid interfaces
in heterogeneous catalysis and
chemical energy conversion

in the Faculty of Chemistry

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I. THE UNIVERSITY OF DUISBURG-ESSEN

Open minded! We are one of the youngest universities in Germany and think in terms of opportunities rather than limitations. In the heart of the Ruhr metropolis, we develop ideas with a future. We are strong in research and teaching, live diversity, promote potential and are committed to upholding educational equality.

The University of Duisburg-Essen (UDE) offers a wide range of subjects, from the humanities, social sciences and educational sciences to economics and engineering, natural sciences and medicine. Since its foundation in 2003, the UDE has developed into a globally recognized research university. This is documented by the top positions in international rankings that have now been achieved. For example, UDE ranks third in the world in terms of the performance of the best universities founded after the turn of the millennium. In the Times Higher Education Ranking, it ranks 13th in the top 150 international universities that are under 50 years old.

Profile focus

The UDE offers a broad range of scientific disciplines including, among others, the interdisciplinary profile areas of nanosciences, biomedical sciences, changes in contemporary societies as well as urban systems with water research. Another key area of research is the lifelong processes of education and socialisation.

Quality standards

Thanks to high quality standards, innovative teaching and learning concepts, the UDE is an attractive place for research-based teaching. To its 43,000 students from more than 130 nations, it offers more than 230 courses of study, 124 of which are courses for educating teachers.

Educational justice

The UDE is regarded as a nationwide model for how equal opportunities in education justice can be implemented at a university. Numerous measures and projects promote young talents with perspective. The UDE sees itself as a lively place of diversity and openness, where students, researchers and employees can develop their potential and willingness to perform. The aim is to achieve a broad-based, resource-saving development.

Partnerships & Cooperation

The UDE is in a strategic partnership with the Ruhr-Universität Bochum and the Technical University Dortmund under the umbrella of the University Alliance Ruhr (UA Ruhr). They cooperate closely in research and teaching and are also present together in three continents with their own international field offices. In addition, UDE maintains partnerships with more than 100 universities around the world.

For more information: http://www.uni-due.de/imperia/md/content/dokumente/ppt/ppt_praesentation_ude_en.pdf

II. THE FACULTY OF CHEMISTRY

The Faculty of Chemistry is located on the Essen campus, where it has modern laboratories and offices in a chemical research building completed in 2008. There are currently 25 professors working in eight different fields: Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Technical Chemistry, Analytical Chemistry, Environmental microbiology and Biotechnology, Chemistry Education and Theoretical Chemistry. Half of these professorships have been filled in the last ten years. The faculty is currently one of the largest chemistry faculties in Germany, with about 1,600 students and nearly 200 doctoral students, who are roughly equally divided over the three courses of study in chemistry, water science and teaching. Every year, about 40-50 young scientists, not only from chemistry, but also from physics, biology and engineering, do their doctorates here. The faculty also cooperates closely with the surrounding universities of applied sciences in Krefeld and Gelsenkirchen.

The Faculty represents the entire breadth of chemical research, from pure basic research to more application-oriented research, such as in the two associated institutes of our Faculty, the German Textile Research Center Northwest (DTNW) in Krefeld and the Rheinisch-Westfälische Institut für Wasserforschung (IWW) in Mülheim. Close research collaborations at all levels also exist with the neighbouring Max Planck Institutes in Mülheim (Coal Research and Chemical Energy Conversion) and Dortmund (Physiological Chemistry). In addition, scientists from these institutions work as honorary professors and private lecturers at our faculty.

The Faculty actively participates in three of the five profile focus areas of the UDE. Activities in the area **Biomedical Sciences** are bioorganic and supramolecular chemistry, biomaterials research, drug development and release as well as biophysical chemistry. Here, in particular working groups from the field of organic, inorganic as well as the physical chemistry, which are also active in the *Center for Medical Biotechnology (ZMB)*. This research area is represented in the Master's programme *Medical-Biological Chemistry*. Scientists of our Faculty cooperate in a wide range of joint projects with colleagues from biology and medicine. Particularly noteworthy is Collaborative Research Centre 1093 *Supramolecular Chemistry of Proteins*, which runs since 2014 and whose second funding period has been successfully approved in 2017. The interdisciplinary focus **Nanoscience** receives contributions from colleagues from the fields of inorganic chemistry, organic chemistry, physical chemistry, technical chemistry and theoretical chemistry. These scientists work on numerous topics in the areas of surface chemistry and functionalization, Nano-materials research, soft materials, self-assembly and self-organization, supramolecular chemistry and crystallography. Working groups of the Faculty of Chemistry are active members of the Center for Nanointegration Duisburg-Essen (CENIDE) and are also involved in the Board of Directors and in the development of the NanoEnergyTechnik-Zentrum (NETZ) in Duisburg. In the fields of heterogeneous catalysis and the energy research, the faculty for is looking closely cooperates with the Max Planck Institutes for Chemical Energy Conversion and for Coal Research in Mülheim and with partners at the Ruhr-Universität Bochum. UDE's Faculty of chemistry manages the Collaborative Research Centre / Transregio 247 *Heterogeneous Oxidation catalysis in the liquid phase*, which has been running since 2018, and which bundles the aforementioned regional competences. In close collaboration, the participating scientists study new catalysts for, among others, electrolysis of water that can help to effectively store regenerative electrical energy in the form of synthetic chemical fuels. Due to the special importance of water as a liquid reaction medium, this area offers fruitful connections to

the research focus **Water research**. The faculty's major participation currently comes from the working groups in analytical and technical chemistry as well as from the Biofilm Centre. Chemists are active as board members in the Centre for Water and Environmental Research (ZWU) and as director of the Institute for Water Research IWW in Mülheim an der Ruhr. The scientific work is focused mainly on microbial processes in aquatic systems, water quality management, new water technologies and the tracking of hazardous substances in the environment. Since 2014, the state of North Rhine-Westphalia has granted the Research Training Group *Future Water*, and recommended funding for the construction of a new research building in Essen, which was achieved with a significant participation of the Faculty of Chemistry.

A further new research building ACTIVE SITES - Center for Method Development to Study Active Sites in their functional Aqueous Environment has been approved by the state of North Rhine-Westphalia and is currently being applied for.

The Faculty's research is heavily funded by third parties. Third-party fundraising has been steadily increasing in recent years and has now stabilised at a high level (currently about 7 million € Faculty-wide).

Many of the research activities outlined above are highly interdisciplinary, which is why almost all working groups of the Faculty, as already pointed out, cooperate intensively with scientists from other faculties of our university (especially biology, medicine, physics, engineering and educational sciences) as well as with other research groups at home and abroad. The faculty is represented by its members in various national and international bodies.

The Faculty and its predecessor institutions have a long tradition in the training of chemists, environmental and water experts (via the curriculum "Water Science") and teachers. All courses of study at the Faculty were successfully re-accredited in 2011/2012. The experience with the BSc/MSc courses introduced in the year 2005 were used to further optimize the teaching content and curriculum in close coordination with the students. The accredited Bachelor/Master's degree programmes ensure a Europe-wide comparability of the diplomas (Bachelor of Science, B.Sc. and Master of Science, M.Sc.), also in the sense of the Europe-wide recognition as Eurobachelor. Of course, the academic achievements are calculated in ECTS credits. In 2017, after the introduction of system accreditation, the first external institutional evaluation took place, which certified the Faculty a high quality in teaching and an internationally visible research strength.

Our faculty attaches particular importance to high-quality teaching: feedback from students on lectures and seminars is regularly evaluated and taken into account for the further development of the teaching offerings. In the first semesters, the prospective scientists and teachers are particularly intensively supervised in tutoring and mentoring groups. The practical training in the basic studies takes place in newly established, modern laboratories, while in the specialization courses a closer connection to the research working groups is encouraged. Even within the scope of the bachelor's degree programme, students typically come into contact with research-relevant topics from the fifth semester onwards – in the Master's degree programme, early involvement in research is a clear focus of UDE's chemistry curriculum.

The Faculty of Chemistry of the University of Duisburg-Essen is firmly involved in international cooperations. The commitment concerns both study programmes and research.

For example, the Faculty is active in the European Union's Erasmus/SOCRATES programme, which promotes temporary stays abroad for students. Current partner universities include:

Katholieke Universiteit Leuven, Belgium
University of Plovdiv, Bulgaria
Université Bordeaux 1, France
Université Louis Pasteur de Strasbourg, France
University of Reading, United Kingdom
Politechnika Gdansk, Poland

In the field of recruiting young talent, the Faculty of Chemistry offers a number of events for high school students. Outstanding high school students can already attend the basic lectures during their school years and obtain proof of achievement for their later studies. The Faculty continues to participate successfully in the Summer University for Women and offers a highly sought-after trial study of chemistry with well over 100 participants in recent years. The Student Experimental Internship (SEPP), set up by the Faculty of Chemistry and available to lower secondary school classes once a week, is already booked out for months in advance.

But also on an individual basis a variety of activities take place in cooperation with schools and the interested public, e.g. lectures by lecturers on site in the schools, support in experimental and project work, visits to school classes at the university or the organization of open days. In addition, the university lecturers supervise a large number of student trainees throughout the year not only within the framework of the mandatory official student internships, but also on a voluntary, individual basis of interested students. For example, an average of about 40 students a year are supervised in the Faculty as part of individual internships.

III. THE CENTER FOR NANOINTEGRATION DUISBURG-ESSEN (CENIDE) AND THE CENTER FOR WATER AND ENVIRONMENTAL ANALYSIS (ZWU)

Nanoscience and nanotechnology form one of the five research priorities of the UDE. Research and teaching in this field are coordinated by CENIDE. CENIDE was founded in 2005 and today connects more than 70 members and their working groups in the fields of physics, chemistry, electrical engineering, mechanical engineering and process engineering as well as biology and medicine. With more than 400 doctoral students, CENIDE is one of the most important research units for nanotechnology and materials science in Europe and plays a leading role in the combination of basic research and applied materials science for the profile focus *Materials Chain* of the University Alliance Ruhr (UA Ruhr, with the Ruhr-Universität Bochum and the Technical University Dortmund). Research at CENIDE focuses on the areas of catalysis, dynamic processes in solids, gas phase synthesis of nanomaterials, magnetism, nanomaterials for health, and nanotechnology in energy applications. Under the coordination of CENIDE, the research building "NanoEnergieTechnikZentrum" (NETZ) was established at the campus in Duisburg. In addition to many research projects, NETZ also houses the DFG core Facility *Interdisciplinary Center for Analytics at the Nanoscale* (ICAN), which offers CENIDE researchers a wide range of complementary characterization methods.

ZWU bundles the water research in the UDE across faculties. The ZWU currently has 158 members from 22 working groups and 4 faculties of the UDE, as well as an increasing number of scientists from the UA Ruhr, the associated institutes as well as other research institutions and associations. The aim of the ZWU is to promote modern environmental research that relates global social change (population growth, urbanisation and mega-cities, global and climate change, air quality, water availability, mobility, sustainable energy supply, etc.) to environmental aspects and investigates the impact on humans. The focus of the ZWU is on water research with a very broad expertise in the fields of water ecology, drinking water treatment and distribution (contamination, assessment, remediation), environmental toxicology and chemistry, water and urban water management, hydrology, hydraulic engineering and water governance with economic and legal competences. The unique selling point of the ZWU compared to other water-research centers in the state of North Rhine Westphalia, but also nationwide, is the interdisciplinary approach lived in large joint projects with partners from natural, engineering, economic, social sciences, which allows the development of innovative complete system solutions.

IV. THE CLUSTER OF EXCELLENCE “RESOLVE” (SOLVATION SCIENCE)

RESOLV is a DFG-funded cluster of excellence on the topic of solvation, which has been established in 2012. Recent advances in spectroscopy, microscopy, synthetic methodology, and computer simulations herald a new era in the understanding and description of solvation processes. The RESOLV research program involving 50 scientists covers three areas:

- i) **Local Solvation Fluctuations in Heterogeneous Systems:**
The global properties of a homogeneous macroscopic system in thermodynamic equilibrium are well known physico-chemical quantities. In RESOLV, these concepts will be further developed with respect to spatially and temporally resolved properties in order to establish new concepts with relevance for solvation science.
- ii) **Solvent Control of Chemical Dynamics and Reactivity:**
Solutes imprint their shape (molecular structure, charge distribution) on the surrounding solvent shells, thus creating solvent arrangements that both in structure and in dynamics deviate from the bulk. In RESOLV, these central aspects, which result from the dynamic aspect of solvation (focus on the solute) and "solvent imprinting" (focus on the solvent), are investigated using time-resolved techniques.
- iii) **Solvation Under Extreme Conditions:**
High pressure, low temperature, and strong confinement will be considered as key stressors that enable us to rigorously modulate solvation properties without changing the chemical identity of the solvent. RESOLV addresses the challenge of how to control conformational dynamics and chemical reactivity under solvent stress conditions.

V. THE COLLABORATIVE RESEARCH CENTER / TRANSREGIO 247 “HETEROGENEOUS OXIDATION CATALYSIS IN THE LIQUID PHASE”

The CRC/TRR 247 is a DFG-funded research network of the UDE (Speaker University) and the neighbouring Ruhr-Universität Bochum, which was established in 2018. Further participating institutions are the Max Planck Institutes for Chemical Energy Conversion and for Coal Research both in Mülheim/Ruhr as well as the Fritz Haber Institute of the

MPG in Berlin. In 21 sub-projects from the disciplines of chemistry, physics and engineering, the fundamentals of heterogeneous oxidation catalysis in the liquid phase are explored. The aim is to clarify the active centers and reaction mechanisms for selected oxidation reactions in thermal, electro- and photocatalysis. For this purpose, iron-cobalt mixed oxides with spinel and perovskite structure-type are synthesized, extensively investigated and their catalytic reactivity linked to the results of materials characterization in structure-activity relationships. Therefore, the CRC develops new experimental and theoretical methods in order to understand the dynamics of the catalyst surface in the liquid reaction medium at the atomic level. A special focus is on the clarification of the role of structural defects and microstructural properties for activity and selectivity in heterogeneous catalysis.

V. PHYSICAL CHEMISTRY IN DUISBURG-ESSEN

Physical chemistry is currently represented by one W3 professorship (Prof. Sebastian Schlücker) and two W2 professorships (Prof. Jochen Gutmann and Prof. Christian Mayer). The research area of the Schlücker group is molecular bio- and nano-photonics. For the targeted localization and quantification of proteins, methods of vibrational Raman spectroscopy and imaging in combination with molecularly functionalized noble metal nanoparticles are used. A second focus of the group is the development and application of linear and nonlinear laser spectroscopic methods for label-free monitoring of molecular recognition processes and ultrafast non-equilibrium processes. The Gutmann group is working on interface-dominated systems. A special focus is on textiles and model colloids and their surface functionalization. Their functional characterization is performed by scanning probe microscopy and scattering methods. The Mayer group is engaged in nuclear magnetic resonance spectroscopy on soft matter. Special research areas are the development of nanocapsules as oxygen carriers for artificial blood substitutes and the experimental evolution of membrane vesicles.

VI. REQUIREMENTS FOR THE POSITION "W3-PROFESSORSHIP PHYSICAL CHEMISTRY OF LIQUID/SOLID INTERFACES IN HETEROGENEOUS CATALYSIS AND CHEMICAL ENERGY CONVERSION"

1. Research

Eligible candidates have an excellent track record and international visibility in the physical chemistry of heterogeneous electro-, photo-, or thermal catalysis and will establish an innovative research program with a focus on spectroscopy, model catalysis, surface/interface science or method development, with a clear perspective to study reaction mechanisms and kinetics.

Applicants should present a research program that strengthens the faculty's current focus on in-situ studies of chemical reactions at liquid/solid interfaces by innovative physico-chemical methods. The new professorship will be closely integrated in the Cluster of Excellence RESOLV (www.solvation.de) and in the CRC/TRR 247 (www.trr247.de). Intense collaborations with existing research groups within the Faculty of Chemistry, the Center for Nanointegration Duisburg-Essen (CENIDE), and the Centre of Water and Environmental Research (ZWU) are expected.

2. Teaching

Full commitment to teaching in physical chemistry in chemistry and related subjects at all levels and full width is expected. Active participation in academic self-administration is expected.

3. Other requirements

Particular emphasis is placed on the willingness to cooperate within UDE and to participate in existing and future major research cooperations. Publications in peer-reviewed journals are expected, as well as ideally already initial experiences with third-party funded research projects and in interdisciplinary research collaborations.

4. Nature and expenditure of time of the activities

This professorship is attributed with the normal teaching deputation of 9 hours per week per semester. In addition, the jobholder is responsible for participation in tasks of academic self-administration.

V. ENDOWMENT

1. Staff/Personal

Details of the future generous endowment of the chair (personal/staff, rooms, annual budgetary funds and infrastructure) will be presented to the invited candidates in person and shown during the inspection of the corresponding labs and offices in the physical chemistry.

2. Rooms/Infrastructure

Appropriate lab and office space at the campus in Essen is ensured. In addition to rooms in the chemistry building S05, further labs may be used in the NanoEnergieTechnik Zentrum as well as in the FutureWaterCampus and Active Sites. The exact number and size of rooms shall be determined in the context of the appeal hearing and negotiated depending on the needs and requirements.

3. Ongoing funds

The jobholder will receive an appropriate share of the available ongoing funds of the Physical Chemistry. These budgets are assigned annually by the Faculty and their amount depends on the overall budget situation of the Faculty as part of the university's decentralized budgeting.

4. Infrastructure

The Faculty of Chemistry has several central analytical service units (including nuclear magnetic resonance spectroscopy (NMR), mass spectrometry (MS), electron microscopy, elemental analysis, X-ray diffraction and polymer characterization) which can be used in addition to the facilities at the campus in Duisburg (NETZ, ICAN).

VI. LEGAL FRAMEWORK

With the Act on Higher Education of the State of North Rhine-Westphalia (Higher Education Act - HG) of 31.10.2006, the university system was fundamentally redesigned from 1 January 2007.

Since then, universities have been state-sponsored, legal bodies governed by public law. State funding is based on its tasks, agreed objectives and services. They have a global budget and are not subject to any instructions to the Ministry of Innovation, Science, Research and Technology of the State of North Rhine-Westphalia.

Legal status of university teachers: Professors are, if the legal requirements are met, in principle employed for life in the civil service. Professors can also be employed in a private service relationship.

For more information (laws, ordinances, etc.), please visit:

https://www.uni-due.de/verwaltung/organisation/peo_professoren.php

VII. SALARY

The *Besoldungsordnung W* regulates the salary of university teachers and includes grades W1, W2 and W3.

The basic salaries are age-independent and can be increased for W2 and W3 by allowances (benefits). This is generally not possible for W1 positions. Such performance-related salary components in W2 and W3 positions can be awarded

- on the occasion of hearings of an appeal (**appeal benefits**),
- for special achievements in research, teaching, art, further education and the promotion of young talent (**special benefits**) and
- for the performance of functions or special tasks within the framework of university self-administration or university management (**functional benefits**)

In certain circumstances, so-called **research and teaching allowances** may be paid from the resources of private third parties.

Temporary benefits are linked to target agreements in the context of appeal and stay negotiations.

In the context of appeal hearings, the appeal benefits are individually negotiated with the rector of the University of Duisburg-Essen.

The current grades (North Rhine-Westphalia) for grades W1, W2 and W3 can be found under <http://www.lbv.nrw.de/beztab/beso.php>.

Information and legal bases on W-salary (NRW) can be found on the Internet at:

https://www.uni-due.de/verwaltung/organisation/peo_links.php

<http://www.hochschulverband.de/cms1/w-besoldung.html>