Leibniz Institute for Catalysis

LIKAT ROSTOCK

Annual Report 2025

In Focus: a New Chemistry

Imprint

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Leibniz Institute for Catalysis

LIKAT ROSTOCK

Annual Report 2025

30 Years Leibniz Association

A LOOK INSIDE

Well Positioned for the Future

Two eventful years lie behind us, the staff of the Leibniz Institute for Catalysis in Rostock. Probably the most significant event was the extremely positive result of the regular evaluation in 2023. In its report, the independent expert commission of the Leibniz Association's Senate attested to LIKAT's “outstanding research results.”

Our working groups published a wealth of scientific findings on novel catalysts and processes in internationally renowned journals. Some of the processes developed have been put into practice, with “great success,” as the evaluation report also noted. The Executive Board would like to take this opportunity to thank the 300 or so LIKAT employees for their contribution to this great success.

Prof. Dr. Robert Francke, Scientific Director

Catalysts, as we explore them, play a key role in global efforts to transform the energy and raw materials base from fossil fuels to sustainable sources. And in these efforts, we were able to further expand our leading position in 2023 and 2024.

Take research into hydrogen, a promising source of energy for the energy transition, for example. Our research teams are developing innovative catalytic concepts for its production and chemical storage. Their findings are significant both for energy supply, for example in rural areas, and for the production of higher hydrocarbons in circular processes that do not require natural gas, oil, or coal and are CO_2-neutral.

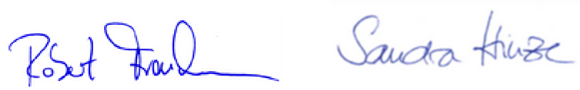
With the approval of a so-called small strategic institutional expansion by the Leibniz Association, LIKAT can now place this work on a broader footing. The “special circumstances” include both the establishment of a “Leibniz Transfer Lab for Sustainable Energy and Material Transformation (LTLNES)” and a new research group headed by Dr. Christoph Wulf. Both will help to secure operations and research at our institute's “Catalysis2Scale” technical center.

Chemists at our institute are among the best in the world. This is demonstrated, for example, by the discovery of the Azide Wittig reaction, a new form of the Wittig reaction that is of great importance in organic chemistry for the synthesis of functional molecules. The original aim of the research was to develop a phosphorus-based ligand, but experiments conducted as part of a doctoral thesis by PD Dr. habil. Christian Hering-Junghans resulted in a completely different substance. Through consistent research into the causes, the group arrived at a variant of the famous synthesis route, which caused quite a stir among experts.

Digitalization is transforming our working world. At our institute, we are developing programs that enable all data from catalysis research experiments to be documented in a machine-readable format. Such data is used to train AI models, and there are examples of this at LIKAT. Dr. David Linke recently received the Digital Chemist Award from the NDFI4Cat consortium for his commitment to these developments.

Our successes demonstrate that LIKAT's matrix structure, comprising ten research departments and six topics (Topic fields = TF), is proving highly effective. It makes it easier for teams to collaborate across disciplinary boundaries, even at short notice, on current topics. LIKAT has also positioned itself well with its new management model, which was introduced at the suggestion of its long-standing director, Prof. Dr. Matthias Beller. Since the end of 2023, the institute has been managed according to the principle of co-leadership. Every two years, the Board nominates a new primus inter pares from among its members as scientific director. There has also been a change in the commercial management, which is now being handled on an interim basis.

Climate change, geopolitical developments, and attacks on democratic rules and principles are presenting humanity with difficult and enormously complex challenges. To overcome these challenges, individual societies need smart decisions, sustainable technologies, and, above all, committed stakeholders. We feel well equipped to play our part.



Dr. Sandra Hinze, Commercial Director (prov.)

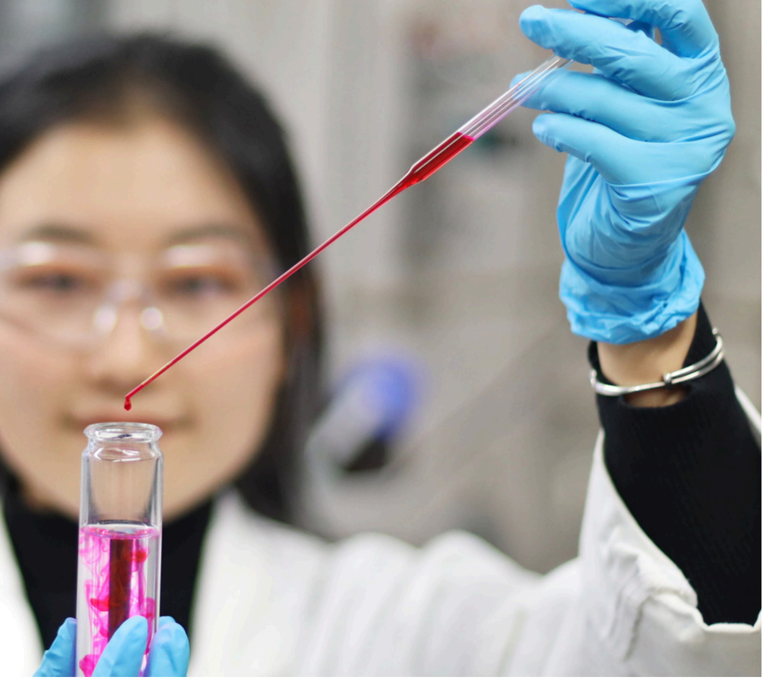
LIKAT -
Catalysis Research in Rostock for over 70 Years

Almost all products for everyday use and industry are created through chemical processes, and catalysts are involved in four out of five of these reactions. Catalysts are also increasingly being used in the life sciences, energy supply, and climate and environmental protection.
At the Leibniz Institute for Catalysis in Rostock, or LIKAT for short, more than 300 employees are researching the fundamentals of catalyzed material conversion of raw materials from increasingly sustainable sources into basic chemicals such as hydrogen and methanol, as well as into recyclable, reusable chemicals and materials. Today, LIKAT is one of the largest publicly funded research institutions in its field in Europe. It draws on more than seven decades of expertise in this field.

It all began with processes for producing artificial butter to feed people after the war. In 1952, the two professors Günther Rienäcker and Wolfgang Langenbeck founded the Institute for Catalysis Research, the first research institute in Europe dedicated exclusively to catalysis. Even back then, their goal was to transfer the results of basic research into practical chemical products and processes. One of the institute's milestones was the commercialization of the Isicom process in 1986, a therapeutic agent for the treatment of Parkinson's disease, as the world's second process for organometallic chiral catalysis.
In 1959, the institute split. Homogeneous catalysis remained in Rostock and later became part of the German Academy of Sciences of the GDR as the Institute for Organic Catalysis Research (IfOK). The heterogeneous catalysis division moved to Berlin, where it established itself as the Institute for Inorganic Catalysis Research and later became part of the Central Institute for Physical Chemistry of the Academy of Sciences.

After German reunification and the evaluation of the academy institutes, the Berlin section was incorporated into the Institute for Applied Chemistry Berlin-Adlershof (ACA), founded in 1994. The IfOK in Rostock became a state research institute of Mecklenburg-Western Pomerania, whose reorientation toward current fields of research was supported by the Max Planck Society through the establishment of two working groups: “Complex Catalysis” and “Asymmetric Catalysis.”
Following an extremely positive evaluation by the Science Council, the Rostock institute was accepted into the Leibniz Association in 2003.
The merger of the Rostock and Berlin ACA institutes in 2005 brought homogeneous and heterogeneous catalysis research back together under one roof in Rostock. As the Leibniz Institute for Catalysis Research, it integrated other complementary fields such as photocatalysis and electrocatalysis.

Left: Institute for Organic Catalysis Research (IfOK) in the Buchbinderstraße Rostock, Above: Institute for Applied Chemistry Berlin-Adlershof (ACA)



In Focus - a New Chemistry

Current research in topic 6, “New products and processes”: CO_2 as a raw material. Closed phosphorus cycles. Recycling and upcycling of plastics.

By Prof. Dr. Torsten Beweries, TF spokesperson

Topic 6 (TF 06) is one of the three materially-oriented Topics at LIKAT. Under our umbrella, the working groups explore chemical reactions and compounds from their fundamentals.

Fundamental Knowledge Growth: Our Strategic Goals

We are therefore laying the foundations for catalytic concepts that will help replace coal, oil, and natural gas as raw materials in the chemical industry, close material cycles, and establish a resource-, environment-, and climate-friendly chemical industry. For example, we want to make unreactive molecules usable for chemical processes and help produce bio-based plastics and recycle them efficiently. In a nutshell, these are our strategic goals.This strategy is reflected in the results of our research over the past year with a clarity that is quite surprising. One of the advantages of working in our TF 6 is that we can focus less narrowly than others. Instead, we try out many different things, address fundamental questions, and sometimes stray from the main road and take a side street.

What is expected of us is primarily knowledge of fundamental interrelationships rather than quick problem solving in the form of a practical connection or a chemical process. We are free to deal with anything and everything, so to speak, as long as it promises a fundamental increase in knowledge. For this reason, during the evaluation in early 2023, a colleague mockingly referred to our subject area as a “general store.”

That's okay with me. After all, we have our strategy! And of course, I am extremely pleased with the conclusion of our retrospective review of our highlights: namely, that what we discovered and developed over the past few months is pretty much exactly what we set out to do.
The annual report will illustrate this with three examples.

First Highlight: from Greenhouse Gas to Raw Material – CO_2.

A number of groups at our institute are investigating new, perhaps previously underestimated, or at least little explored ways of activating small molecules. A typical example is carbon dioxide, that unavoidable by-product of our civilization that is threatening our climate.
It is an elegant idea to use CO_2 in sophisticated chemical processes by employing the greenhouse gas as a C1 synthesis building block for higher-value molecules required in products for industry and everyday life. Nature shows us how it's done. It uses sunlight to convert CO_2 and water into glucose, a complex C6 molecule with six carbon atoms.

However, CO_2 is chemically extremely inert and only reacts in the presence of catalysts in the laboratory. Since the 1980s, laboratories have repeatedly reported such catalytic reactions without systematically investigating them. One example is oxalate, the salt of oxalic acid, which occurs in spinach, for example. It is formed by the combination of two CO_2 molecules to form C_2O_4, a C2 building block. Only recently has systematic interest in these reactions been awakened. In April 2024, the DFG approved an application from the University of Rostock and LIKAT for a graduate college on catalytic coupling reactions with CO_2.
And we have succeeded in synthesizing intermediate products using CO_2, which we can then use to produce more complex molecules, including drugs. Prof. Dr. Thomas Werner, an associate scientist at the University of Paderborn, provides information on the current state of research in this annual report on pages 12 ff.

Second Highlight: “Beautiful Chemistry” with Phosphorus and Closed Cycles

Phosphorus is essential for living organisms. Compounds containing this chemical element play a key role in the structure and function of organisms in areas such as DNA and cellular energy supply. More than 90 percent of global phosphorus production is used as fertilizer worldwide. However, reserves are running out.

Prof. Dr. Torsten Beweries

– LIKAT helped explore strategies for more efficient phosphorus use, which significantly reduce demand from deposits and enable closed cycles. To this end, the Phosphorus Science Campus brought together the Leibniz Institutes in Mecklenburg-Western Pomerania from 2015 to 2024. LIKAT participated in the “Phosphorus in Catalysis and Synthesis” cluster, primarily in the fields of organocatalysis, ligand design, and enzyme catalysis.
In our experience, phosphorus can be used to create “beautiful chemistry.” For example, the working group led by PD Dr. habil. Christian Hering-Junghans has presented very interesting work in the development of new ligands. Christian Hering-Junghans received the 2024 Lecturer Award from the Chemical Industry Fund (FCI), which is presented annually to a particularly qualified young scientist in the field of chemistry and biochemistry. He reports on the work of his group on pages 15 ff.

Third Highlight: Recycling and Upcycling of Plastics

The littering of the world with old plastic is a serious threat to humans and nature. Every year, millions of tons of plastic waste end up uncontrolled in the landscape and in the sea. The global community needs, among other things, efficient recycling of plastic waste. With its research, the working group led by PD Dr. habil. Esteban Mejía is opening up two remarkable paths to a genuine circular economy for the important plastic class of silicones.

On the one hand, they can depolymerize silicone waste, i.e., break it down completely into its original chemical components. They recover the monomers, which can be reprocessed as raw materials to make new silicones. On the other hand, they are able to produce higher-quality materials from the silicone waste: solid silicone resins that are highly resistant to mechanical and thermal stress. This is one of our institute's most important industrial collaborations. Esteban Mejìa will report on this starting on page 19.

In addition, since mid-2024, the Leibniz Association has been funding a cluster of excellence project dedicated to the degradation of bio-based plastics as part of the “Sustain – Knowledge for Sustainable Development” research network. Bio-based plastics are polymers whose building blocks can be obtained from renewable raw materials. The network is coordinated by LIKAT, and its spokesperson is Thomas Werner.

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Research Groups Active in TF 06

- **Polymer Chemistry & Catalysis**
  PD Dr. habil. Esteban Mejía
- **Analytical Department**
  PD Dr. habil. Wolfgang Baumann
- Catalysis with Early Transition Metals
  Dr. Fabian Reiß
- **Reaction Mechanisms**
  Prof. Dr. Evgenii Kondratenko
- **High-Throughput Technologies**
  N.N.
- **Reaction Engineering**
  Dr. David Linke
- Catalysis with Late Transition Metals
  Prof. Dr. Torsten Beweries
- **Catalysis for Heterocycles**
  Prof. Dr. Xiao-Feng Wu
- **Selective Catalytic Synthesis Methods**
  Prof. Dr. Eszter Baráth
- **Catalytic Functionalizations**
  Dr. Jola Pospech
- **Hydroformylations**
  Dr. Jens Holz
- **Sustainable Redox Reactions**
  Dr. Kathrin Junge
- **Molecular Electrochemistry**
  Prof. Dr. Robert Francke
- **Catalyst Design for Electrosynthesis**
  Dr. Bernd Müller
- **Biocatalysis & Reaction Engineering/Membrane Processes**
  Dr. Udo Kragl
- **Homogeneous Catalysis for Life Sciences**
  Dr. Helfried Neumann
- **Material Design**
  Prof. Dr. Axel Schulz
- **Catalytic Cycloadditions**
  Prof. Dr. Marko Hapke
- **Resource Efficient Catalysis**
  Prof. Dr. Thomas Werner
- **Catalysis with Phosphorus Materials**
  PD Dr. habil. Christian Hering-Junghans

Sophisticated Chemistry with CO_2

Kinetic Racemization and Methylated or Formylated Amines

Prof. Dr. Thomas Werner

Fossil fuels are increasingly falling into disrepute – primarily in the public consciousness because the mass combustion of coal, oil, and natural gas threatens the climate with its CO_2 emissions. However, global efforts to replace fossil fuels and raw materials with renewable, sustainable alternatives have another existential reason: coal, oil, and natural gas are rapidly running out.
This means that the most important sources of carbon are drying up, and carbon is an indispensable component of most things we encounter in everyday life. From medicines to toothbrushes. This is the background to our commitment to sophisticated chemistry with carbon dioxide. CO_2 is a virtually inexhaustible source of carbon.

Indispensable Carbon

A brief digression for non-chemists: Carbon is unique among chemical elements in its ability to form rings and long chains with itself, thereby incorporating other elements and groups of molecules for an incredible number of functions. In this way, the element with the symbol C forms millions of chemical compounds and becomes an essential structural element both for the biosphere—in the form of proteins, fats, and carbohydrates, for example—and for industrial production.
Given the massive, threatening emissions of CO_2 into the atmosphere, it seems elegant to use the greenhouse gas as a building block for higher-value molecules. However, it is chemically very stable and difficult to activate.
Recently, doctoral students in our department explored two synthetic routes for converting CO_2 into common chemicals that are suitable for further processing. In the first case, we obtain cyclic carbonates through kinetic racemic separation, highly selectively as pure enantiomers. In the second case, we attach a methyl group or an aldehyde unit to amines using CO_2. Both will be explained in more detail here.

Cyclic Carbonates

Our cyclic carbonates are produced in catalytic reactions through the addition of CO2 to epoxides. The product is usually a racemic mixture, i.e., it exists in two compounds that have the same molecular formula but differ in their spatial structure and behave like mirror images. Chemists refer to these as enantiomers. Separating the mixture is difficult but necessary, as usually only one of the two enantiomers has the desired chemical effect.
As part of the Phosphorus Campus, we developed a process based on an enzyme in cooperation with the University of Rostock. We succeeded in obtaining enantiomerically pure cyclic carbonates, which is essential for pharmaceutical production, for example. In fact, we were able to prove that certain active ingredients can be produced in enantiomerically pure form using the chiral building block of a cyclic carbonate. The enzyme used as a catalyst for this purpose is known from detergent production, is readily available, and can be recycled.
Cyclic carbonates are also used in the manufacture of lithium-ion batteries and as plasticizers, as an alternative to phthalates. And they are gaining importance in the development of bio-based polycarbonates. Incidentally, the Leibniz Association's new SAW project "Sustain," led by our institute, will focus on the degradation of these and other polymers.

Methylation and Formylation

Now for the second task. Here, we use carbon dioxide to achieve two things: either to attach a methyl group (CH_3) to the nitrogen atom of the amine or an aldehyde unit (CHO). Both are common reactions for the synthesis of precursors for high-quality products, such as pharmaceutical derivatives. Traditionally, the carbon in the molecules, i.e. the C in the molecular formula, comes from fossil raw materials. The reaction pathways are often complicated, with many by-products.
However, if you want to methylate amines using CO_2, you need a reducing agent for the reaction. We use silanes for this purpose, some of which can be obtained from waste products of silicone production. The reactions take place at relatively mild temperatures and pressures. This favors their use in the pharmaceutical industry, even at a relatively late stage in the synthesis of active ingredients, which already have a complex and therefore sensitive molecular structure.

Publications

C. Terazzi, A. Spannenberg, J. von Langermann, T. Werner, *ChemCatChem* **2023**, 15, e202300917. (DOI: e202300917) Chemoenzymatic Synthesis of Chiral Building Blocks Based on the Kinetic Resolution of Glycerol-Derived Cyclic Carbonates.
C. Ren, C.Terazzi, T. Werner, *Green Chem.* **2024**, *26*, 439-447. (DOI: 10.1039/D3GC03993E) Tuneable reduction of CO2 – organocatalyzed selective formylation and methylation of amines.
C. Ren, A. Spannenberg, T. Werner, *ACS Sustainable Chem. Eng.* **2024**, 10969-10977. (DOI: 10.1021/acssuschemeng.4c03464) Phosphonium-Salt-Catalyzed N-Methylation and N-Formylation of Amines with CO2.

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Prof. Dr. Thomas Werner
(Photo: University of Paderborn)

Reactivities Beyond the Usual Paths

Phosphorus Chemistry and Azide Wittig Reaction

PD Dr. habil. Christian Hering-Junghans

One main area of our research focuses on how phosphorus can be used for new reactions. We also want to develop new compounds with the phosphorus atom in which we can use this chemical element as little as possible.

Phosphorous as Catalyst?

Firstly, we develop new ligands. These structures surround the reactive center of a catalyst and, depending on their design, can also influence the catalytic process.
When we look at the chemistry of phosphorus in low oxidation states, we see reactions that chemists are more familiar with from transition metals: for example, a completely voluntary ligand exchange that is also reversible.
This is exactly what happens with metallic catalysts. This brings us closer to answering the question of the extent to which the phosphorus atom itself can be used as a catalyst.
Secondly, our research results reveal new possibilities for chemical bonds with phosphorus. These include phosphorus-aluminum multiple bonds, which are highly reactive and allow us to explore completely new reaction pathways with great potential for non-metal catalysis. This is becoming increasingly important, as there is a trend in catalytic chemistry away from metals, especially precious metals.

Strong Response from Scientific Community

Sometimes chance also leads us to “beautiful chemistry.” Currently, for example, in the development of a new ligand, where we strayed from the path and ended up with a completely different class of substances than expected. In the end, we discovered a synthesis route that we call the azide Wittig reaction. It represents a new form of the established Wittig reaction, which was awarded the Nobel Prize in 1979. The announcement of our paper alone attracted many views on social media and was shared multiple times online.

Kushik, PhD student under Dr. habil. Christian Hering-Junghans, stumbled upon the new Azide Wittig reaction by chance.

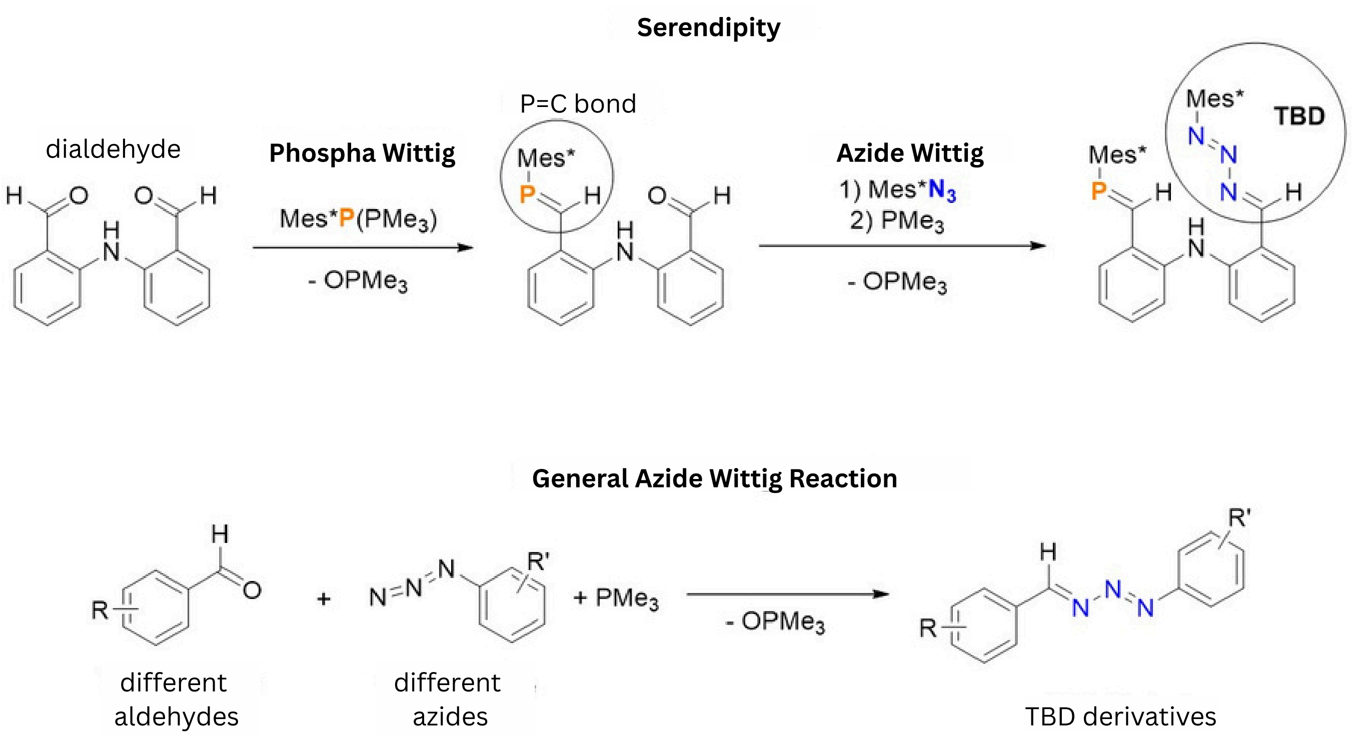

Fig. above: In the dialdehyde, only one of the aldehyde groups reacted with the Phospha Wittig reagent. The second aldehyde group remained intact for further reactions. In this way, an azide was successfully introduced in a further reaction step. Below: This reaction can be described as an Azide Wittig reaction. It will also be used by the Hering-Junghans research group to develop new ligands.

The Wittig reaction is indispensable for the production of functional molecules with double bonds between carbon atoms (C=C), which are ubiquitous structural motifs in organic synthesis. Our doctoral candidate Kushik, lead author of the paper in the journal *Angewandte Chemie*, was investigating such double bonds. For a new ligand, he wanted to incorporate phosphorus-carbon double bonds (P=C) into a dialdehyde. However, the reaction did not progress beyond the first step. Only one aldehyde group was converted into the desired P=C bond. The other remained free.
After thorough consultation with all those involved in TF 06, we saw an opportunity in the remaining aldehyde group to insert a nitrogen-carbon double bond (N=C) in addition to the P=C double bond. To do this, Kushik used a derivative of the Wittig reaction, namely the Aza Wittig reaction. In this reaction, an organic azide, whose characteristic structure includes three
nitrogen atoms linked together, and a base with the persistent aldehyde are converted into an imine unit, whereby nitrogen is released in addition to the incorporation of the N=C double bond.

Totally Unexpected: a New Approach to Triazabutadiene

This appeared to work, at least NMR spectrometry indicated the incorporation of an N=C double bond. Additional verification by X-ray diffraction then revealed a surprising result.
Instead of an imine unit, a triazabutadiene unit (TBD) had formed in the reaction, a completely different substance!

PD Dr. habil. Christian Hering-Junghans

In the course of the study, we were able to prove that the entire azide unit is transferred in the new reaction. We opted for the large Mes*azide, whereby the size protected the azide from nitrogen (N_2) being split off. We later learned that such a reaction had already been published for the first time in 2019. However, this reaction was not investigated further systematically.
In its structure, the TBD from our laboratory has been modified in an advantageous way compared to previously known structures. This enables us to use the azide-Wittig reaction for the further development of novel ligands.
The structure of the TBD from our laboratory has been modified in a beneficial way compared to previously known structures. This enables us to use the azide Wittig reaction for the further development of novel ligands.

Original Publication:
K. Kushik, A. Petrov, D. Ranieri, L. Edelmann, T. Beweries, C. Hering-Junghans, *Angew. Chem. Int. Ed.* **2024**, e202412982. (DOI: https://doi.org/10.1002/anie.202412982) The Azide-Wittig Reaction.

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Closed Cycle for Silicones

Recycling and Upcycling Replace Energy-intensive and Environmentally Harmful Processes.

PD Dr. habil. Esteban Mejía

Images of mountains of plastic waste washed up on the world's coastlines have become almost iconic symbols of one of the most unfortunate environmental consequences of human activity. Four-fifths of all plastic waste ends up in ecological systems uncontrolled, amounting to several million tons every year. The international community has not yet been able to agree on a UN agreement to halt this development.

Everyone is aware that plastics are indispensable and that society cannot function without them. However, there is no way around the demand to radically reduce their consumption and to avoid waste as much as possible or return it to the cycle.

If at all, plastic waste is currently mostly recycled using mechanical processes, processed into recycled material and turned into new products. These products are, of course, of inferior quality and can no longer be used universally, for example in the medical sector. After two or three cycles, even plastic from recycled material ends up in the trash.

What can help here is a genuine circular economy. Plastic waste would have to be chemically converted back into raw materials from which high-quality plastic could be produced again. At LIKAT, we have taken a step toward this circular economy in close cooperation with industry, namely with a process for an important class of plastics: silicones.

Why Silicones?

We encounter these polymers as robust and tear-resistant materials in all areas, from baby pacifiers to computer keyboards. Their structure is half organic, half inorganic, which makes them seem somewhat exotic to us chemists. They can be equipped with functional groups with a wide variety of properties and processed into elastomers, resins, oils, and more. However, no one seems to have been particularly interested in reusing them so far, and there are hardly any suggestions in the literature. Perhaps this is because the actual raw material is cheap and widely available. A good quarter of the earth's crust consists of silicon, mostly bound in silicon oxide, SiO_2. That's sand!

However, manufacturing silicones is very complex. Processes involving temperatures of up to 3,000 degrees Celsius are required to first break the silicon-oxygen bond and extract silicon or silicon iron. In a further process, known as the Müller-Rochow synthesis, silicone with the typical silicon-carbon bonds is produced. This synthesis, which is around 80 years old, requires additives that are considered harmful to the environment.

Of Geopolitical Interest

The universality of this material makes silicones extremely attractive. This also makes the material

interesting from a geopolitical perspective. China is by far the world's leading producer of silicon and ferrosilicon, followed by Russia. The Asia-Pacific region also dominates the silicone market, and the Müller-Rochow process is virtually unknown in Europe. Understandably, the domestic industry wants to tap into its own sources.
This is the background against which doctoral student Shamna Salahudeen developed a catalytic process in my working group that breaks down silicone polymers and makes them available again as raw materials. What remains are monomers in which the silicon-carbon bonds have remained completely intact. As we have been able to show, these chemical building blocks can be polymerized again and recombined to form high-quality elastomers.
Such a circular process could make the economy independent of exports of fresh raw materials or new silicone products in the future. This is one of the most extensive industrial projects at LIKAT. The company provides us with samples, namely real industry-relevant waste samples, and enables us to scale up to kilogram quantities at its facilities. We were able to file three patents in 2024, with two more to follow.

PD Dr. habil. Esteban Mejía

Life-Cycle-Assessment and High Refinement

Recently, another PhD student, Malte Kunz, has been analyzing all the energy and economic aspects of the process, from the treatment of silicon waste to the new product, in a life cycle assessment. This is also part of the cooperation with our industry partner. The aim is to determine the carbon footprint of the process, i.e., how CO2-neutral and sustainable it will ultimately be. And everything is taken into account: raw materials, transport, energy for all work steps, all by-products and their disposal. Ultimately, these results will determine the direction in which we pursue our research.
In addition to converting silicone from waste back into a raw material, another path to a future circular economy for plastics has surprisingly opened up for us. Instead of breaking silicone down into its building blocks, we can “cook” it into silicone resins and refine it even further. The result of this chemical upcycling is, so to speak, a high-tech material: a very strong, mechanically and thermally highly resilient material that could also be suitable as an outer skin for ships, aircraft, and rockets.

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2024 in Review

10 | 23

Visiting Professorship:
In 2023/2024, **PD Dr. habil. Christian Hering-Junghans** represented the Chair of Inorganic Chemistry at Otto von Guericke University Magdeburg for one year in addition to his role as group leader at LIKAT.

11 | 23

The **Senate of the Leibniz Association confirmed** the Leibniz Institute for Catalysis (LIKAT) in Rostock's **excellent research achievements** with international visibility and recommended further funding by the federal and state governments. Particular emphasis was placed on the significant progress made in the development of sustainable chemical processes, the high level of third-party funding, and the successful transfer of research results into industrial applications.

12 | 23

PD Dr. habil. Esteban Mejía has been awarded a **visiting professorship** at the Faculty of Chemistry and Life Science by Hanoi University of Science and Technology, starting on December 1, 2023.

01 | 24

Dr. Jola Pospech has been elected as the new **ombudsperson** for LIKAT;
Dr. Annette Surkus will serve as the deputy ombudsperson.

03 | 24

Dr. Jola Pospech has been honored with the **ADUC Award** by the Working Group of German University Professors of Chemistry (ADUC).

04 | 24

Prof. Dr. Matthias Beller was awarded the **Wilhelm Ostwald Medal** by the Saxon Academy of Sciences in Leipzig on April 12, 2024.

05 | 24

Prof. Dr. Jagadeesh Rajenahally wurde von der Royal Society of Chemistry (RSC) der Titel „Fellow of the Royal Society of Chemistry (FRSC)“ verliehen.

06 | 24

Prof. Dr. Eszter Baráth was appointed Chair of Synergies between Homogeneous and Heterogeneous Catalysis at the Institute of Chemistry at the University of Rostock on June 1, 2024.

06 | 24

PD Dr. habil. Christian Hering-Junghans received the **Lecturer Award from the Chemical Industry Fund (FCI)** for “scientific excellence in independent research work and above-average achievements in teaching.”

06 | 24

It was a close call for **Rostock's Eleven: Carolin Stein** (RD Beller, “Catalysis for Energy” Group) took second place.

09 | 24

Research on the radio (LOHRO):
Wellenlänge Wissenschaft is all about research and science in Mecklenburg-Western Pomerania.
Carolin Stein reported on how baking powder can be used to store hydrogen.

10 | 24

Kick-off meeting SPECTRE: The new SPECTRE graduate training program at the University of Rostock and LIKAT has officially begun. The German Research Foundation (DFG) is funding the project with over six million euros for an initial period of five years. LIKAT is represented in the team of spokespersons by **Prof. Dr. Torsten Beweries** and **Dr. Jola Pospech**.

11 | 24

Dr. Sara Kopf (ehem. FB Beller, TG “Katalyse für Life Sciences”) wurde mit dem **Promotionspreis der Leibniz-Gemeinschaft** ausgezeichnet. Die drei Preisträger:innen waren aus einem Pool von rund 800 Bewerbern nominiert worden

12 | 24

Prof. Dr. Matthias Beller has been re-elected for another two-year term as **one of the vice presidents of the Leibniz Association.**

12 | 24

Jannik Thaens, **Germán Lopez Robledo** and **Ole Albrecht** have been elected as the new representatives for PhDs and postdocs.

LIKAT in Numbers (2023 | 2024)

Cutoff date 31.12.2024

21,02 | 22,78
Budget
(in million €)

13,74 | 13,06
Basic Funding
(in million €)

7,28 | 9,72
External Funding
(in million €)

2,16 | 3,76
thereof Industrial Funding
(in Mio. €)

130 | 130
Scientists (incl. PostDocs)

98 | 106
PhD Students

66 | 68
Science Supporting Staff (incl. Administration)

- | 5
Bachelor

7 | 15
Master

29 | 22
Doctorates

2 | 1
Habilitation

§

12 | 13
Patents

- | 4
Transfers

324 | 261
Publications *

114 | 136
thereof Open Access

197 | 124
thereof IP > 5

1 | -
Books

2 | 3
Book Chapters

*

Analytical Department of LIKAT

Powerful analytical methods are essential for successful chemical work. This requires not only the availability of modern equipment, but also support from qualified personnel.
The Analytics service area supports the working groups at the Leibniz Institute for Catalysis with the necessary analytical services. The required methods are developed in close consultation with the clients and adapted to the specific issues at hand. The large analytical equipment is maintained by scientists with many years of experience in the respective methods.

PD Dr. habil. Wolfgang Baumann,
Head of Service Department "Analytics"

Chromatography (GC & HPLC): Chromatographic methods separate and analyze mixtures of substances, identify components, and quantify them. Extensive experience exists particularly in enantiomer analysis. New analytical methods are being developed for specific separation problems.

Mass Spectrometry (MS): Mass spectrometry (MS) is used for structural elucidation, trace analysis, and determination of atomic masses, isotope abundances, and elemental compositions. In analytics, MS instruments are used independently or in combination with chromatography (GC-MS, LC-MS).

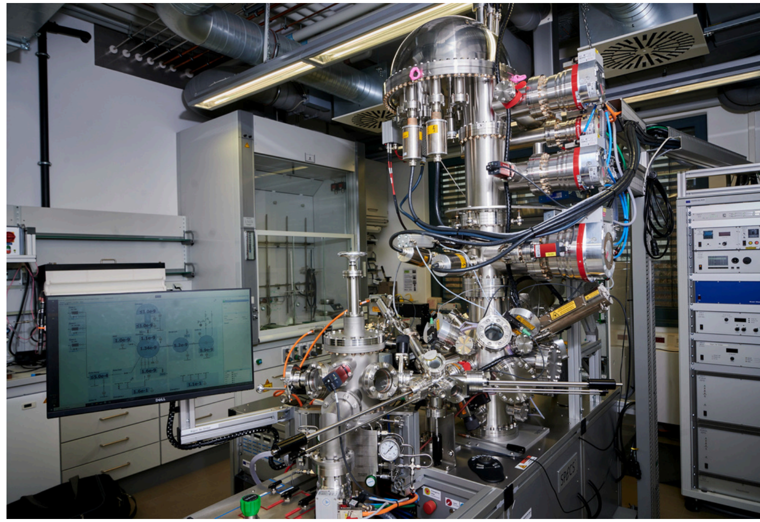
NMR Spectroscopy (Nuclear Manetic Resonance Spectroscopy): High-resolution NMR spectroscopy is essential in synthetic chemistry for structural elucidation, quantitative analysis, and research into molecular dynamics. In the field of nuclear magnetic resonance, we work closely with the Institute of Chemistry at the University of Rostock.

Single Crystal X-ray Diffraction Analysis: X-ray diffraction on single crystals enables the analysis of crystal structures, including constitution, conformation, and 3D packing. One focus of powder diffractometry is the investigation of catalysts under operating conditions. Methods for sample characterization, including *in-operando* techniques, are continuously being improved.

Elektron Microscopy: Many heterogeneous catalysts consist of particles with sizes in the nm range. The morphology of these particles is one of the main factors determining catalytic activity. Electron microscopy visualizes structures in the nano and sub-nanometer range. Atomic resolution is possible in STEM mode.

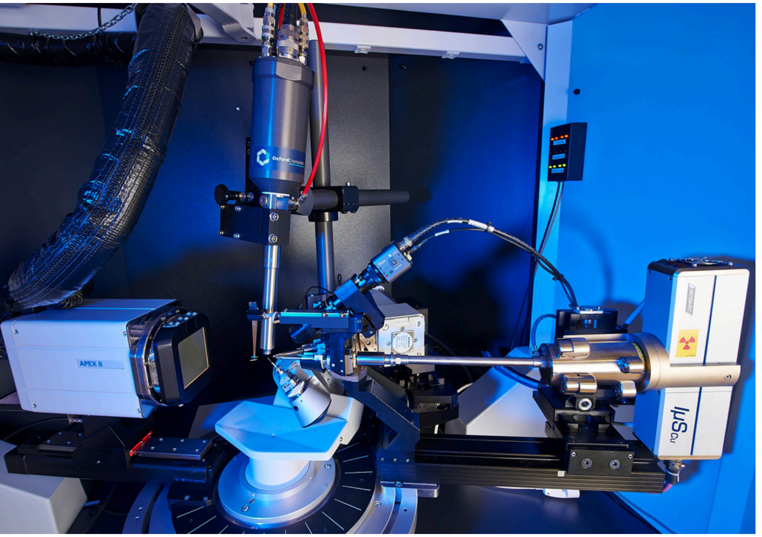
Photoelektron Spectroscopy (XPS): Photoelectron spectroscopy is a proven method of surface analysis based on the photoelectric effect. It identifies atoms and bonding states. Modern developments enable measurements at higher pressures. LIKAT has an ultra-high vacuum spectrometer and a high-pressure in situ photoelectron spectrometer (NAP-XPS – Near Ambient Pressure X-ray Photoelectron Spectroscopy) for catalyst analyses.

Optical Spectroscopies (IR, UV/Vis und CD): These methods work with electromagnetic waves, which propagate essentially according to the laws of classical optics. The infrared (thermal radiation), visible and near-ultraviolet wavelength ranges are primarily used for spectroscopic purposes. The interactions of electromagnetic radiation with matter provide information about molecular structures and electronic states.

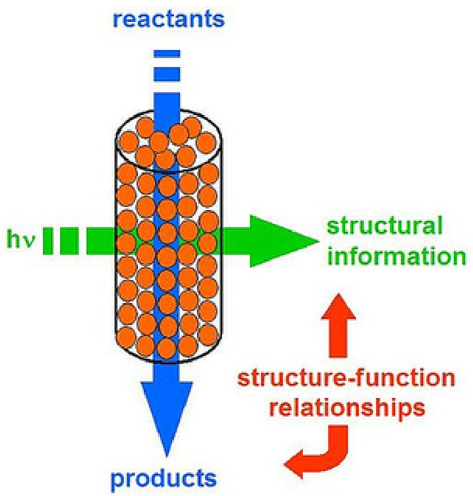


Above: The NAP-XPS enables in-situ measurements. Catalyst materials can be examined in the presence of (reactive) gases.
(Photo: LIKAT/Nordlicht)

Left: 400 MHz NMR device from Bruker for routine analysis



Bruker Kappa APEX II Duo X-ray diffractometer for routine measurements



The in situ principle: The measurement is performed parallel to the reaction process. This allows conclusions to be drawn about the reaction process.

Elemental Analysis: (EA: AAS, ICP-OES, RFA, Combustion analysis, titration, and photometry, including digestion methods)
Both organic and inorganic materials can be analyzed for their elemental composition. If necessary, solids are dissolved using melting or acid digestion, the latter with microwave assistance.

***In-situ* Spectroscopy:** *In-situ* methods are particularly valuable for catalysis research because they enable reacting systems to be observed directly (without sampling). Sampling followed by analysis often cannot guarantee that the state under realistic reaction conditions is accurately described. Therefore, in addition to the service department Analytics, the research department "Methods for Applied Catalysis" (Prof. Dr. Evgenii Kondratenko) is also intensively involved in these methods.

In the research area "Methods for Applied Catalysis," further techniques are being used, new measurement methods developed, and methods combined that are specifically used in catalysis research to elucidate structure-activity relationships and reaction mechanisms.

Contact:
PD Dr. habil. Wolfgang Baumann
Head of "Service Department Analytics"
wolfgang.baumann@catalysis.de
0381 1281 201

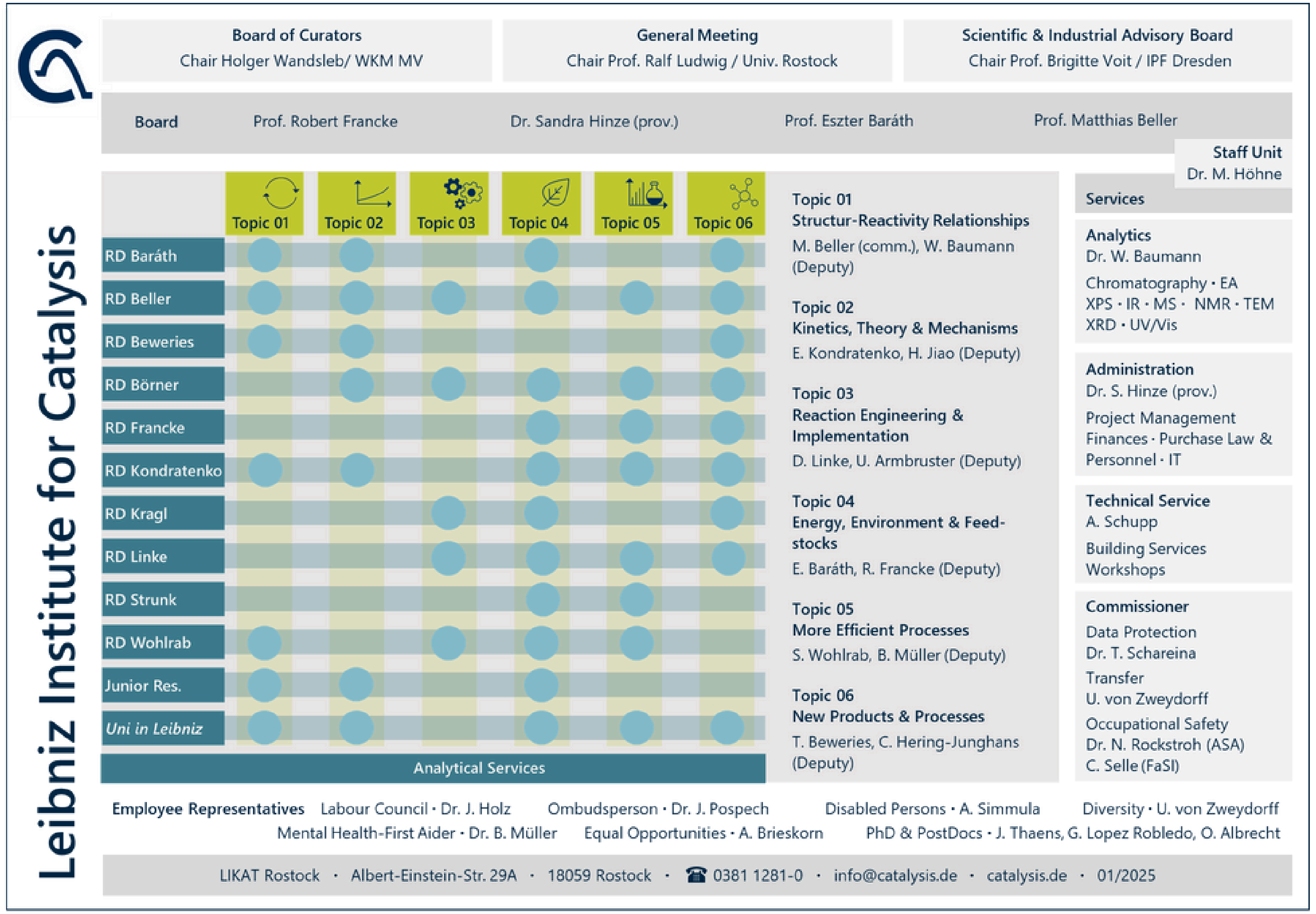
Transmission electron microscope at LIKAT.

In collaboration with the Department of Life, Light & Matter at the University of Rostock, an aberration-corrected STEM with a cold field emitter for higher energy resolution (0.3 eV) and corresponding analytical equipment is in operation. This microscope is equipped with special holders from Protochips Inc. for in-situ measurements, which include heating experiments in vacuum, heating in gaseous environments, heating or biasing in static or dynamic liquid media.

(Photo: LIKAT/Nordlicht)

Organization and Research Structure

The research work at LIKAT is divided into six topics (TF, Themenfelder) that are considered to be forward-looking, socially relevant fields of research. Institute members work across these TF, bringing together expertise from different research departments (RD) and research groups. This matrix structure promotes interdisciplinary exchange on research questions and enables LIKAT to maximize its technical potential. A total of six topics have been identified, which are addressed by ten existing research departments and their individual research groups.



methodologically oriented

TF 01
Strukture-Reactivity Relationships
Spokesperson: Prof. Dr. Matthias Beller
Deputy: PD Dr. habil. Wolfgang Baumann

TF 02
Kinetics, Theory & Mechanisms
Spokesperson: Prof. Dr. Evgenii Kondratenko
Deputy: Prof. Dr. Haijun Jiao

TF 03
Reaction Engneering & Implementation
Spokesperson: Dr. David Linke
Deputy: Dr.-Ing. Udo Armbruster

materially oriented

TF 04
Energy, Environment & Feedstocks
Spokesperson: Prof. Dr. Eszter Baráth
Deputy: Prof. Dr. Robert Francke

TF 05
More Efficient Processes
Spokesperson: Dr. Sebastian Wohlrab
Deputy: Dr. Bernd Müller

TF 06
New Products & Processes
Spokesperson: Prof. Dr. Torsten Beweries
Deputy: PD Dr. habil. Christian Hering-Junghans

“Uni in Leibniz” - Associated Program

Bridge Between University and LIKAT – Joint Research for Innovation

LIKAT has been working closely with the University of Rostock since 2006, with a scientific foundation in the “Uni in Leibniz” association model. Since 2020, this model has been realigned as an ideas competition. Researchers at the university can submit project ideas in close cooperation with LIKAT scientists, whose implementation is supported by joint supervision of doctoral students and funding for the doctoral position plus annual material resources.

Six doctoral projects were funded in the previous funding phase (2021-2024): Prof. Axel Schulz/Prof. Torsten Beweries, Prof. Malte Brasholz/Prof. Jennifer Strunk, Prof. Björn Corzilius/Prof. Angelika Brückner, Prof. Klaus Neymeyr/Prof. Robert Francke, Prof. Wolfram Seidel/Prof. Robert Francke.

For the current funding phase (2025–2028), five projects were selected for funding from twelve high-quality project outlines. The selection was made by members of the LIKAT Science and Industry Advisory Board based on criteria such as originality, impact, and strategic fit with the institute. Despite fierce competition, promising projects were identified that will create new synergies between the university and LIKAT.
The program not only strengthens young scientists, but also the strategic networking between university and non-university research institutions and offers an ideal environment for independent, forward-looking research.

The professors currently associated with LIKAT are:

Prof. Dr. Klaus Boldt University of Rostock | IfCh

Prof. Dr. Malte Brasholz University of Rostock | IfCh

Prof. Dr. Peter Huy University of Rostock | IfCh

Prof. Dr. Klaus Neymeyr University of Rostock | IfM

Prof. Dr. Ralf Zimmermann University of Rostock | IfCh

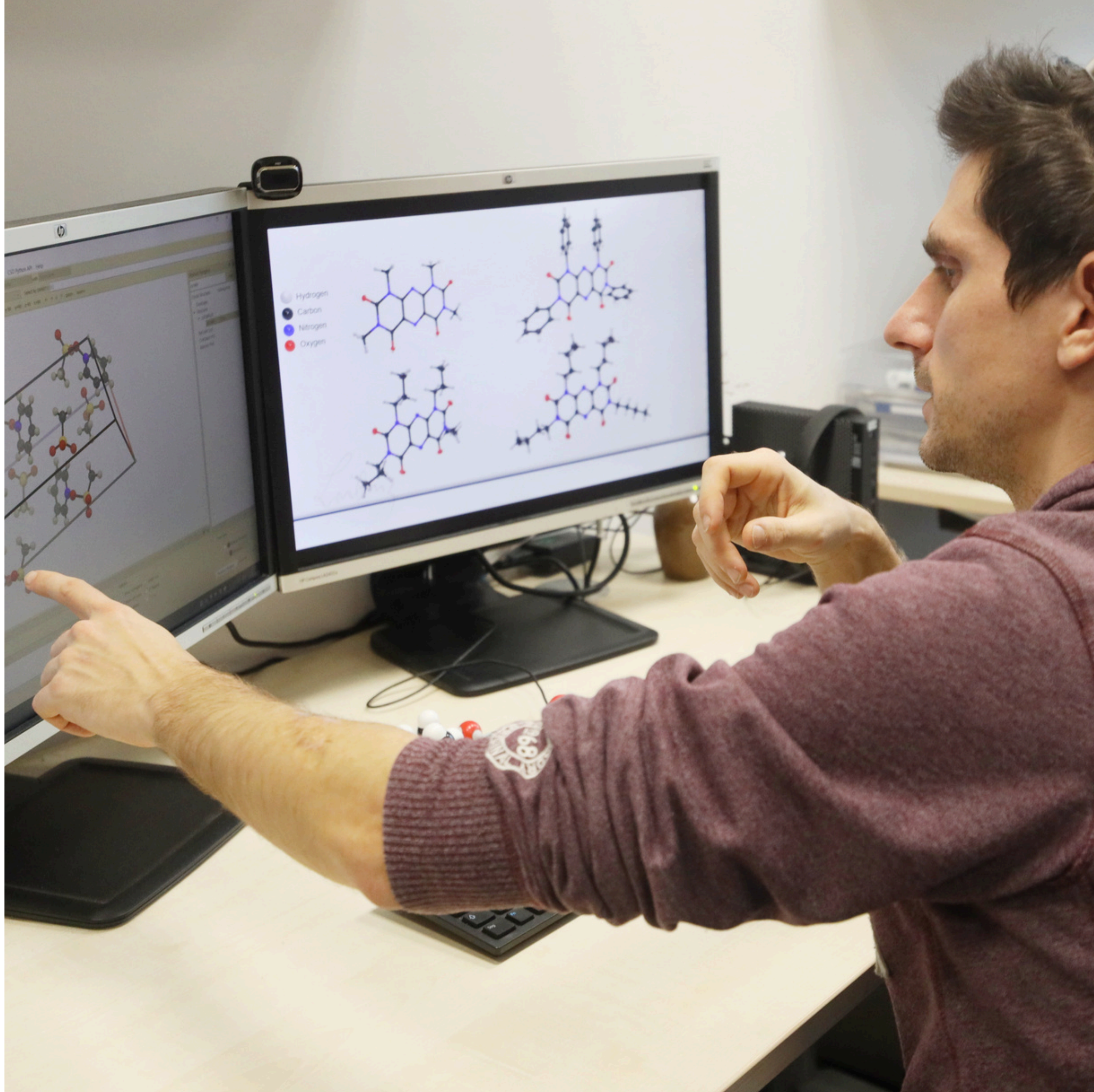
Prof. Dr. Axel Schulz University of Rostock | IfCh

Prof. Dr. Marko Hapke Johannes Kepler University Linz

Prof. Dr. Ralf Ludwig University of Rostock | IfCh

Prof. Dr. Thomas Werner University of Paderborn

Prof. Dr. Jennifer Strunk Technical University of Munich



Career, Family Time, and Appreciation of Diversity

Equal Opportunities in Practice at LIKAT

By Annett Brieskorn, Equal Opportunities Officer

Parents know how it is: an epidemic at daycare, a sick child, or other emergencies. These things always come unexpectedly, grandparents aren't always available, and there are urgent tasks waiting to be done at work. Sometimes, young mothers and fathers decide on the spur of the moment to take their children with them. School-age children may be able to entertain themselves.

But a three-year-old toddler?
Our institute now has a solution for even the youngest children: the Kids Box, which can be unfolded in the office to create a mobile play corner with storage space and all kinds of toys. Word of this purchase in December 2024 spread quickly, and it was soon procured and assembled—within arm's reach of parents, so to speak.

Since the beginning of 2024, employees have had access to the mobile children's room at LIKAT. (Photo: C. Wulf)

Our institute is strongly committed to family-friendly structures as part of our responsibility to provide equal opportunities to all employees—regardless of gender, age, ethnic origin, individual characteristics, or disabilities. LIKAT develops an equality plan every two years, and since 2006, the equality officer and her deputy have been responsible for ensuring compliance. For many years, this was done under the leadership of Dr. Sandra Hinze, who took on a new role on an interim basis at the beginning of 2025. Our institute regularly applies for the Total E-Quality certificate and has always proven itself worthy of it. In 2026, we will defend the title for the sixth time.

Our appreciation for diversity is evident even at first glance in the hallways and offices and laboratories: people from more than 40 countries work here. Many of them are working on their doctorates and postdoctoral qualifications. And it is good for all of them to know that their career path is perfectly compatible with family planning and family time.

If the birth of a child or other family responsibilities, or even prolonged illness, delay the completion of a dissertation, for example, the person concerned may extend their research stay at LIKAT beyond the specified period. The necessary funds come from our joint fund, which the institute has set up for such cases. This fund is also available if the child of an institute member needs to be accommodated at short notice, for example because the parent has to present their research at a conference.

All of this makes it easier for young people to take on leadership roles. This is especially true for women, and gender equality is particularly important to the institute's board. In fact, the proportion of women varies across departments and levels; it is much higher in science support than in research.

At the highest management level, the gender ratio is currently equal and in line with our target quotas for 2025. Unfortunately, the same cannot be said for the management level below: only one of the nine departments at LIKAT is headed by a woman, and there are only four women among the heads of the 30 research groups. Achieving true gender equality here remains a major challenge.
This also applies to the next generation, i.e., students, doctoral candidates, and postdocs, where only one in three positions is held by a woman. This makes it all the more important for us to promote women at early stages of their careers. At least one of the two junior research groups at LIKAT is headed by a woman, Olga Bokareva, a qualified chemist. Olga Bokareva proudly points out that she employs four female doctoral students in her group, even though her field, theory and quantum chemistry, is still considered a male domain.

Equality team 2023 at LIKAT (from left to right): Annett Brieskorn, Kathleen Schubert, and Sandra Hinze (Photo: M. Höhne)

LIKAT is therefore developing strong role models for women. And the institute is considering ways in which we can ensure that such role models for female chemists can also reach the public beyond the internal sphere.
That is why we decided to revisit a proposal from our institute for a highly creative project that had been put on hold four years ago by the BMBF for financial reasons: to design graphic novels about the lives and work of female chemists at our institute. A preliminary application is currently being submitted to the European Social Fund, in which LIKAT is once again participating with the graphic novel concept.

Research Groups at LIKAT


Applied Carbonylations
Dr. Ralf Jackstell


Inorganic Funktional Materials
Dr. Sebastian Wohlrab


Heterogeneous Electrocatalysts
Dr. Annette-Enrica Surkus

High-throughput Technologies
N.N.


Homogeneous Catalysis for Life Sciences
Dr. Helfried Neumann


Hydroformylations
Dr. Jens Holz


Catalyst Design for Elektrosynthesis
Dr. Bernd Müller


Catalysis with Early Transition Metals
Dr. Fabian Reiß


Catalysis for Energy
Dr. Henrik Junge


Catalysis with Phosphorous Materials
Dr. habil. Christian Hering-Junghans


Catalysis with Late Transition Metals
Prof. Dr. Torsten Beweries

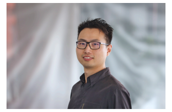

Catalysis for Heterocycles
Prof. Dr. Xiao-Feng Wu


Catalytic Functionalizations
Dr. Jola Pospech


Magnetic Resonance & X-ray Methods
Dr. Jabor Rabeah


Mechanisms of Homogeneous Catalysis
Dr. Hans-Joachim Drexler


Homogeneous Catalysis with Renewables
Dr. Sergey Tin


Continuous electrochemical processes
Dr. Wen Ju


Micro Reaction Engineering
Dr. Norbert Steinfeldt


Molecular Electrochemistry
Prof. Dr. Robert Francke

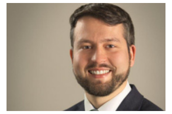

Sustainable Redox Reactions
Dr. Kathrin Junge


Surface Chemistry in Applied Catalysis
Dr. Ali Abdel-Mageed


Optical in situ-Spectroscopy
Dr. Christoph Kubis


Photocatalytic CO2 Reductions
Dr. Tim Peppel


Polymer Chemistry & Catalysis
Dr. habil. Esteban Mejía


Process Development & Transfer
Dr. Christoph Wulf


Reaction Mechanisms
Prof. Dr. Evgenii Kondratenko

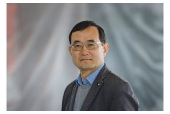

Reaction Engineering
Dr. David Linke


Selective Catalytic Synthesis Methods
Prof. Dr. Eszter Baráth


Structure-Function-Correlations
Prof. Dr. Jennifer Strunk


Catalysis for Sustainable Synthesis
Prof. Dr. Jagadeesh Rajenahally


Technology Oriented Processes
Dr.-Ing. Udo Armbruster


Theory of Catalysis
Prof. Dr. Haijun Jiao


Modern Organic Chemistry
Junior Research Group (JRG)
Dr. Osama El-Sepelgy


Modelling Metal Complexes in Catalytic Reactions *JRG*
Dr. habil. Olga Bokareva

30 Years Leibniz Association