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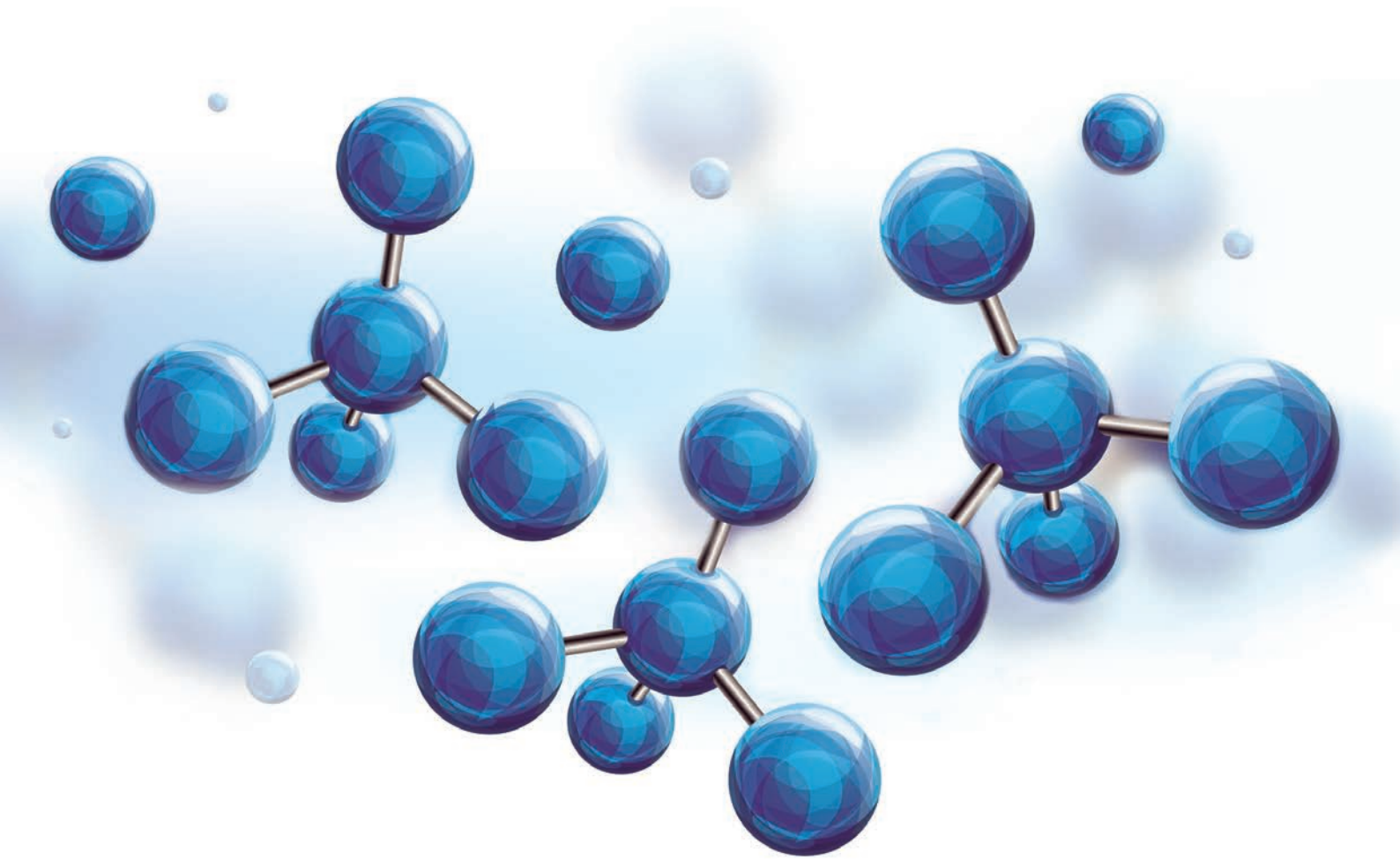
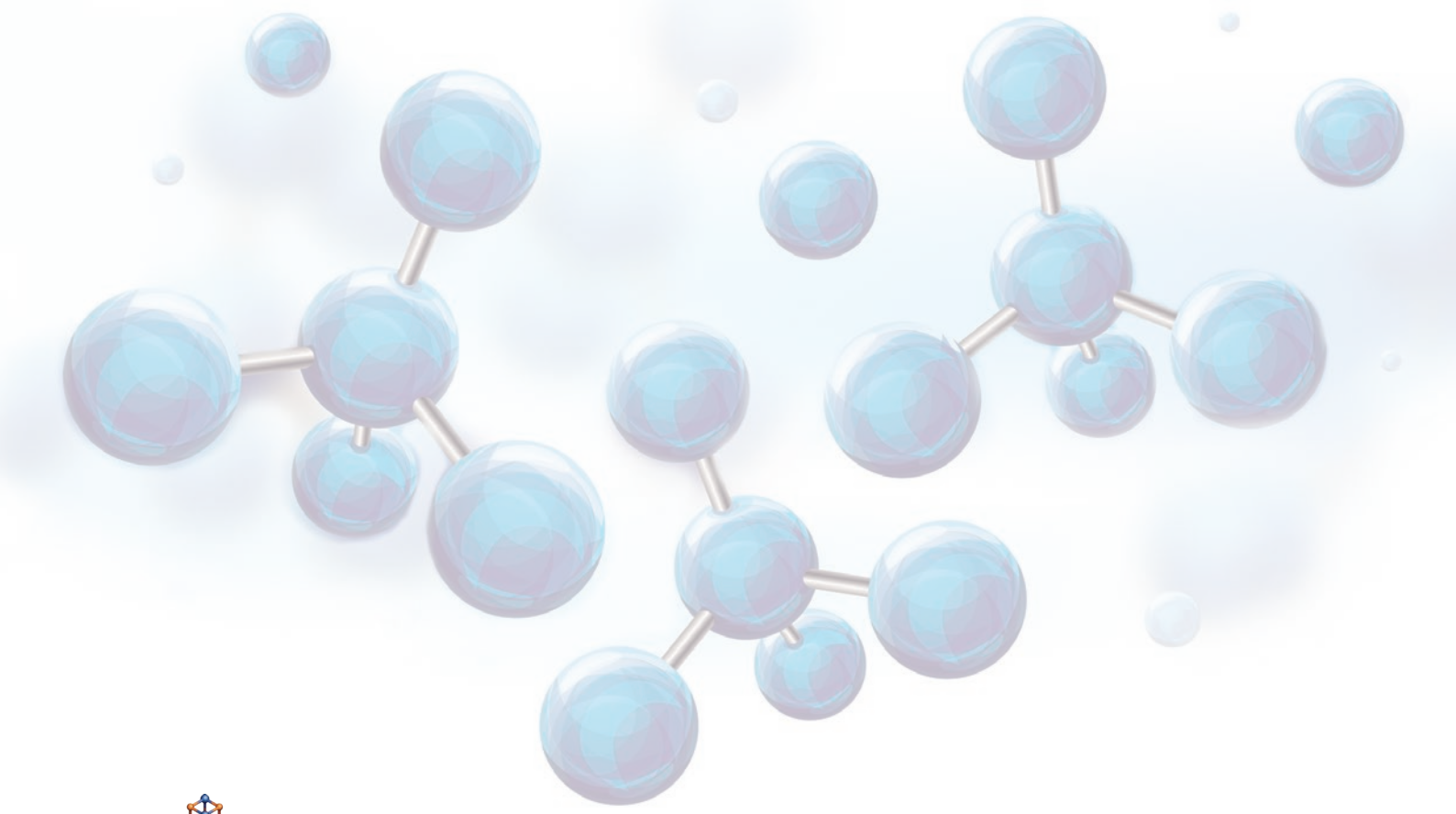
Unifying Concepts in Catalysis



10 YEARS
Cluster of Excellence



unicat

Four universities, two Max Planck Institutes, and the Charité are involved in UniCat.
The Technische Universität Berlin (TU Berlin) is its host university.
UniCat is supported by the German Research Foundation (Deutsche Forschungsgemeinschaft – DFG)
with funds from the Excellence Initiative of the German Federal and State Governments.

Technische Universität Berlin

Freie Universität Berlin

Humboldt-Universität zu Berlin

Universität Potsdam

FHI

CHARITÉ
UNIVERSITÄTSMEDIZIN BERLIN

Content

A Decade of Catalysis Research in Berlin

UniCat is the only Cluster of Excellence in Germany that focuses on the important topic of catalysis research. Following on from its success in the first round of the Excellence Initiative in 2007, the cluster was able to secure a further five years of funding in 2012.

Catalysis research is an interdisciplinary field per se. The same has been true for the cluster from the very beginning: scientists from Chemistry, Physics, Biology and the Engineering Sciences work closely together here. Currently, around 250 researchers from 28 nations are employed in a total of 42 research groups. Research is conducted into a wide range of topics that stretches from the chemical conversion of methane to ethylene, to the chemical and biological activation of carbon dioxide, to the catalytic generation of hydrogen from water with sunlight as the source of energy, and beyond to the synthesis of agents with the aid of artificial enzymes.

Among the most visible signs of UniCat's success are the establishment of BasCat and the Inkulab as well as nearly 1,700 publications and 50 patent registrations. Since 2011, UniCat and BASF have been operating BasCat, a so-called JointLab, at the Campus Charlottenburg. The goal is to establish a direct connection between innovative fundamental research and industrial application. Since early 2017, the Inkulab, a laboratory container fully equipped with ventilation, laboratory furniture and safety devices, has been providing entrepreneurs from the fields of Chemistry, Life Sciences and Nanotechnology with free laboratory workstations and a startup incubation program.

Technische Universität Berlin is the head institution of the UniCat cluster. Three further universities and two non-university institutions are involved: Freie Universität Berlin, Humboldt-Universität zu Berlin and the University of Potsdam as well as the Fritz Haber Institute of the Max Planck Society in Berlin-Dahlem and the Max Planck Institute of Colloids and Interfaces in Potsdam-Golm. Since 2012, a junior research group at the university hospital Charité – Universitätsmedizin Berlin has also been part of the cluster.

Members of UniCat's Executive Board and further UniCat research group leaders (from left to right): Ralph Krähnert (TU Berlin), Elke Dittmann (University of Potsdam), Joachim Sauer (HU Berlin), Holger Dobbek (HU Berlin), Ulla Wollenberger (University of Potsdam), Robert Bittl (FU Berlin), Matthias Drieß (TU Berlin), Maria Andrea Mroginski (TU Berlin) and Reinhard Schomäcker (TU Berlin).

From 12 to 14 July UniCat celebrates its 10th anniversary.

www.unicat.tu-berlin.de/10years

TU Berlin/Philipp Arnoldt

UniCat in Figures

Within the Cluster of Excellence UniCat, chemists, physicists, biologists and engineers from four universities and two Max Planck Institutes collaborate across the boundaries of their disciplines and institutions: Technische Universität Berlin (host university), Freie Universität Berlin, Humboldt Universität zu Berlin, the University of Potsdam, the Fritz Haber Institute of the Max Planck Society (Berlin), the Max Planck Institute of Colloids and Interfaces (Potsdam). 2012 one research group of the Charité – Universitätsmedizin Berlin joined the cluster.

250 researchers from more than 28 nations, 42 research groups, 8 to 10 administrative and technical employees, and 3 student employees

Proportion of women: 30.4 %

Doctoral students: 55 %

Post-doctoral researchers: 23 %

Around 17 leaders of UniCat research groups have accepted offers of professorship or senior positions from other universities and institutions.

In recent years, around 450 persons have left the cluster for various reasons (completed doctoral theses, post-doctoral positions, appointments as professor, changes in the thematic focus). Many remain scientifically associated with the cluster.

1,688 publications

50 patent registrations

Funds granted from the DFG since 2007: around 50 million euros

35 collaborations with German and international universities and research institutions, 15 collaborations with industrial companies

Where Chemistry Meets Biology

Professor Dr. Matthias Drieß, spokesman for the Cluster of Excellence "UniCat – Unifying Concepts in Catalysis", talks about the successes achieved over the past decade and the plans for the future

Professor Drieß, we are looking back at a decade in the life of the Cluster of Excellence UniCat. How do you view this period, in retrospect?

I view it absolutely as a success story, because, over the past ten years, in collaboration with four universities and two Max Planck Institutes, we have been able to push forward with an extremely difficult research topic, namely, the combination of chemical and biological catalysis. In the academic world, publications are the currency of success. We have produced an abundance of good publications here that never would have been possible without UniCat.

Our cooperation with the company BASF, with whom we operate a joint laboratory called BasCat, is definitely another UniCat success. In this JointLab our primary task is to explore new methods in the field of oxidation catalysis.

I regard it as significant progress that the boundaries between the different subject areas of Chemistry, Biology and Physics have almost been dissolved. At UniCat, close cooperation between all disciplines is just a matter of course, even a necessity. This begins with the doctoral candidates and Master's students, who regularly visit the different laboratories. In order to really understand catalysis in all its forms scientists need to master a wide range of analytical tools – and this is something they can only learn by looking occasionally into fields other than their own.

Can you give us a picture of how this works? Do your doctoral candidates spend time in different laboratories as part of an officially organized procedure?

Communication between colleagues is not something that can be prescribed. People need to know each other – and this does not apply only to the professors but also, especially, to the young people, that is, to the doctoral students. In the case of UniCat, from the very beginning we looked very far ahead and founded a Graduate School as an integral part of the cluster. Students from almost any subject area are accepted there if they wish to earn their Doctorate in one of the UniCat research groups. In the Graduate School, scholarship holders spend their first three months entirely together. That leaves its mark. From the very beginning, we seek to form a tight-knit network between the different disciplines based on the bottom-up principle.

How do you manage to coordinate efficiently such multifaceted and diverse institutions and cultures?

Various factors play a decisive role in this regard. You need to trust each other, and have a common language, to be able to work together, and this takes time to develop. The scientists involved must be able and willing to learn in order to respect or even to understand different approaches. The cluster's visibility in the outside world plays a role – are we perceived as a team? Sustainability can only develop if these "soft" factors are right.

Obviously, the "hard" factors must fit, too, namely, a critical mass of outstanding scientists, good equipment and appropriate resources. Funding is important for this purpose – good research costs a lot of money. However, in my opinion, an intellectual atmosphere of trust is even more crucial.

The difference between a good research location and a mediocre one does not lie in the way the former attracts more funding, but rather in the way it gathers pace and develops its own dynamic. The founding of BasCat is only one example of how we have succeeded in this regard. Industry will only open itself up to this type of cooperation if the resulting scientific output provides something that the company itself cannot provide on its own. However, the establishment

TU Berlin/Ulrich Dahl

Chemist Matthias Drieß, Professor of Inorganic Chemistry at TU Berlin, is one of the most important figures in the management of the Cluster of Excellence UniCat. He is a member of the German National Academy of Sciences Leopoldina and the Berlin-Brandenburg Academy of Sciences and Humanities

of the "Inkulab", the huge number of publications or the high level of interest in UniCat shown by international colleagues speak for themselves, too.

In this context, how important is it to identify yourself with UniCat?
Extremely important. I am explicitly a UniCat scientist and only secondly a TU Berlin scientist. Occasionally, the institutions involved find this hard to cope with. Sometimes, I miss a clear avowal on the part of the university to support and value UniCat in such a way that it really rises above the university as a whole. For example, I find it very important to give newly appointed scientists the feeling that they are valued as intellectual top performers and not mainly as fund raisers. Let me say it again – the intellectual atmosphere is important. This is how UniCat can become a magnet for outstanding international scientists.

What additional value does UniCat create for the different parties involved, for example, for the scientists, the universities, the city of Berlin or for you personally?
For us scientists it is clear: we are part of a research endeavor that cannot be found anywhere else. We reconnoiter border areas. Various institutions conduct top-level catalysis research, either from a chemical or biological point of view. But: why is it so often the case that catalytic processes in Biology are so much more efficient and less complex than what we can ever achieve in chemical catalysis? This kind of research on the interface between Biology and Chemistry only takes place in Berlin.
For the universities, scientific excellence is, of course, a criterion. Scientific expertise often goes together with good teaching. In addition, we educate outstanding young scientists, thereby increasing the visibility of TU Berlin.
For Berlin, such a Cluster of Excellence naturally brings with it a considerable growth in the city's renown as a research location.

The Excellence Initiative is now becoming the Excellence Strategy. What does this mean for UniCat?
90 percent of all products that we hold in our hands every day – be they skin creams, detergents or yogurts – require a catalyst in the course of their production, during which far too many resources are still being wasted. Anyone who speaks about sustainable production is actually speaking about catalysis. Improving the efficiency of a catalyst by one decimal place has an enormous leverage effect with regard to saving energy or conserving resources. And let us not forget the processes that are as yet unknown. We must try to make the world more organic, more sound. We are at a point where we have come to understand many individual components of catalysis rather well. In order to guarantee a sustainable and resource-conserving production in the future, we must now focus more on learning from biological systems how these components can be efficiently and dynamically coupled. In this regard, we need a genuine paradigm shift – and this is also the track we are following with our new application for the Excellence Strategy as UniSysCat. I am very confident that we will master theses future challenges.

THE INTERVIEW WAS CONDUCTED BY KATHARINA JUNG

Faster than Fire

The oxidative coupling of methane is a race against the combustion reaction

TU Berlin/Ulrich Dahl

The mini-plant from Process Engineering, a complete chemical factory in miniature, is also used by UniCat members for the investigation of processes

Natural gas consists of up to 98 percent methane (CH4). The so-called oxidative coupling of methane (OCM) during which the more reactive ethylene – an important raw material in the chemical industry – is generated from the relatively inert methane is one of the so-called "dream reactions" in Chemistry. Professor Dr. Reinhard Schomäcker, Technische Universität Berlin, and his colleagues at UniCat set out to crack this "dream reaction".

The main reaction – the combustion of methane with air (oxygen) – is known from flaring methane during the production of crude oil. The oxidative coupling of methane takes place concurrently, generating ethylene. The scientists searched for a catalyst capable of shifting these two reactions in favor of the valuable ethylene, thereby working even faster than the combustion reaction. "Today we know that part of the reaction takes place on the surface of the catalyst, and the other part in the gas phase. The more reaction there is in the gas phase, the less ethylene is produced," Professor Schomäcker explains.

The goal is to have as much reaction as possible on the surface of the catalyst

„We started out with a catalyst known from the available literature consisting of lithium-doped magnesium oxide. Without success. Step by step, we were able to prove that the catalyst propagated in the textbooks does not work. Only then, in collaboration with our UniCat partners, could we develop our own model catalyst consisting of magnesium oxide."

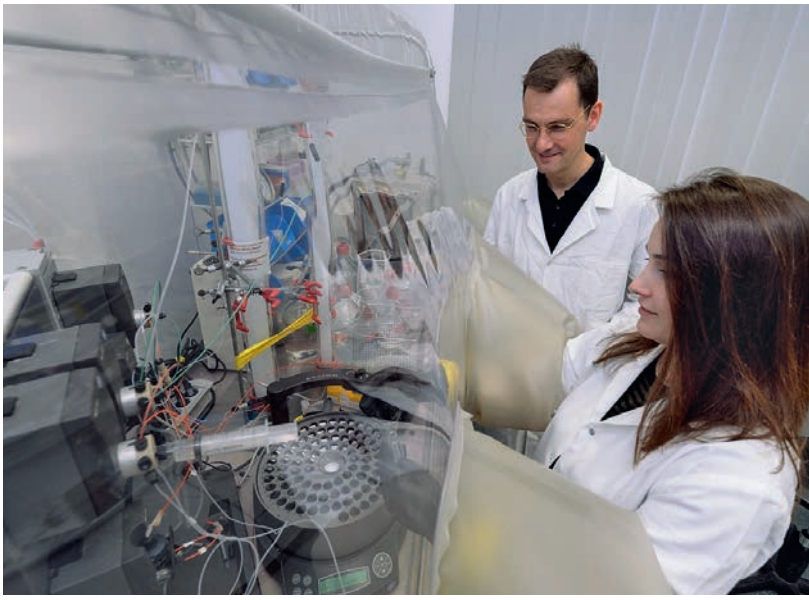
From the very beginning of the project, one of the difficulties was to produce a suitable catalyst in sufficiently large quantities. "A UniCat colleague from Material Sciences finally managed to produce a relatively large quantity (approximately 200 grams) of a promising catalyst. Therefore, for the first time, all groups could analyze the exact same catalyst," says Professor Schomäcker, describing one of the major breakthroughs. This catalyst consisting of a tungsten-sodium-manganese mixture is stable and reactive. Unfortunately, however, it cannot be analyzed spectroscopically due to its complex structure. "Only by comparing the model catalyst with the high-performance catalyst were we able to describe the actual reaction with increasing exactitude and optimize it," says Professor Schomäcker. "

Working together with Professor Dr. Joachim Sauer from Humboldt-Universität zu Berlin, our most important finding was to prove that catalysts only need to provide one or two electrons for the activation of the oxygen. Depending on the number of available electrons, different oxygen species are generated with which the desired, or the undesired, reactions take place." Significant progress was also achieved in cooperation with other UniCat partners, such as Professor Dr. Günter Wozny from Process Engineering. "Parallel to our research, our colleagues built a mini-plant for the production of ethylene, that is, a complete chemical factory in miniature. This is being continuously optimized on the basis of new findings." And with success: today, the ethylene yield has already reached nearly 30 percent.

KATHARINA JUNG

Holger Dobbek and his assistants investigate the catalytic center of natural carbon monoxide dehydrogenases

TU Berlin/UniCat



The Structure Predetermines the Reaction

Activated carbon oxides are important building blocks in biosynthesis

Substances like carbon dioxide (CO_2) are available in huge quantities and therefore ideal precursors for many chemical products. The problem is that CO_2 is rather inert and not particularly reactive. The activation of such small molecules is one of UniCat's focal points.

The activation of carbon dioxide is viewed from two perspectives: Professor Dr. Silke Leimkühler from the University of Potsdam is investigating the conversion of carbon dioxide to formate (formic acid).

"We look at enzymes that generate carbon monoxide (CO) from carbon dioxide (CO_2), and vice versa. For the chemical industry, carbon monoxide is an interesting starting substance, because it is much more reactive than CO_2. In bacteria, two molecules of carbon dioxide initially generate a methyl group and then carbon monoxide, both of which jointly react to acetate (acetic acid). Acetic acid, too, is a basic building block for generating a variety of different products, both within organisms and in industry," explains Professor Dr. Holger Dobbek, Head of the research group for Structural Biology/ Biochemistry at Humboldt-Universität zu Berlin and a member of UniCat.

"We are especially interested in a particular enzyme, carbon monoxide dehydrogenase, that reversibly reduces carbon dioxide to carbon monoxide. This enzyme can do this in a much more efficient and energy-saving way than comparable chemical catalysts."

The crucial point seems to be how to bond the CO_2 and CO to the catalytic center

"The structure of the enzyme was known, but not the electronic interactions. Ultimately, catalysis is always about the displacement of electrons. But how does the nickel in the catalytic center (an iron-nickel cluster) of the enzyme accomplish this electron displacement or, rather, the activation of the carbon monoxide?" says Professor Dobbek, describing the central research question. Unfortunately, this reaction continues to elude the scientists: the bond between the carbon monoxide and the catalytic center is extremely transient and the turnover takes place extremely fast. "We are unable to capture this state," says Professor Dobbek, "therefore we offer cyanide to the enzyme instead of CO. Both are isoelectronic, we assume that the bonding is similar, too. However, cyanide cannot be converted and therefore remains stable."

The exact bond structure was then determined in collaboration with several UniCat partners. The research group led by Professor Dr. Peter Hildebrandt, Head of the subject area of Physical and Biophysical Chemistry at TU Berlin, examined the enzyme spectroscopically, and Professor Dr. Maria Andrea Mroginski, Professor for the Modeling of Biomolecular Systems at TU Berlin, calculated a 3D model of the enzyme based on the entire data available.

"As soon as the structure of the enzyme and the bonding of the substrates are clear, certain reaction mechanisms seem likely", says Professor Dobbek. Parallel to the structural elucidation, other groups are trying to chemically reconstruct the catalytic center. "As we gain new data, these models can be continuously refined. In the future, we want to investigate complexes consisting of many different enzymes. Bacteria use enzymes like a modular kit – a kind of small chemical factory. We want to be able to do the same. How do the active centers of enzymes communicate with each other? How are processes steered in a certain direction? These questions will keep us busy in the future," says Professor Dobbek.

KATHARINA JUNG

From Molecule to Solid

Nano-structured materials can opti

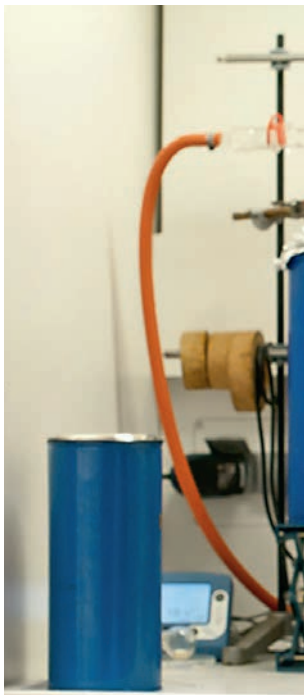
No catalysis research can work without innovative materials chemistry. When it comes to application, the solid state will almost always be the state of choice, simply because it is stable and therefore easier to handle," says Professor Dr. Arne Thomas, Head of the Functional Materials research group at TU Berlin and a UniCat member. "Our specialty is the generation of nanostructured materials, that is, solids that look like porous sponges with pore sizes in the nanometer range. The porous material either serves as a catalyst of its own accord or as a support for catalytic material. This special structure provides an extremly increased surface for catalytic centers, increasing significantly the ratio of turnover to mass."

Professor Thomas' research group cooperates with up to 20 further UniCat groups for the synthesis, characterization and testing of these materials.

From the very beginning, UniCat was also about finding a replacement for the exhausting fossil fuels. "In this regard, the use of solar energy is an almost inevitable concept for the future. With problems that we are well aware of: in solar cells, electricity is generated in a relatively efficient manner, however, only if the sun is actually shining. The storage of electricity still remains difficult and rather ineffective," says Professor Thomas. "One solution could be solar water splitting, with the resulting hydrogen and oxygen being stored separately and, as required, brought together again in order to use the energy released in the process.

The principle has long been known. One of the problems is the fact that there are no viable catalysts available. "We know many enzymes that are highly efficient in this regard, for instance in photosynthesis. From a technological standpoint, expensive precious-metal catalysts are almost equally efficient; however, they cannot be the solution in the long term. We are working on catalyst modifications that only require common metals such as iron, nickel or manganese – or even no metal whatsoever." In doing so, the collaboration between a number of UniCat research

TU Berlin/Ulrich Dahl



One speciality of Prof. Arne Tho

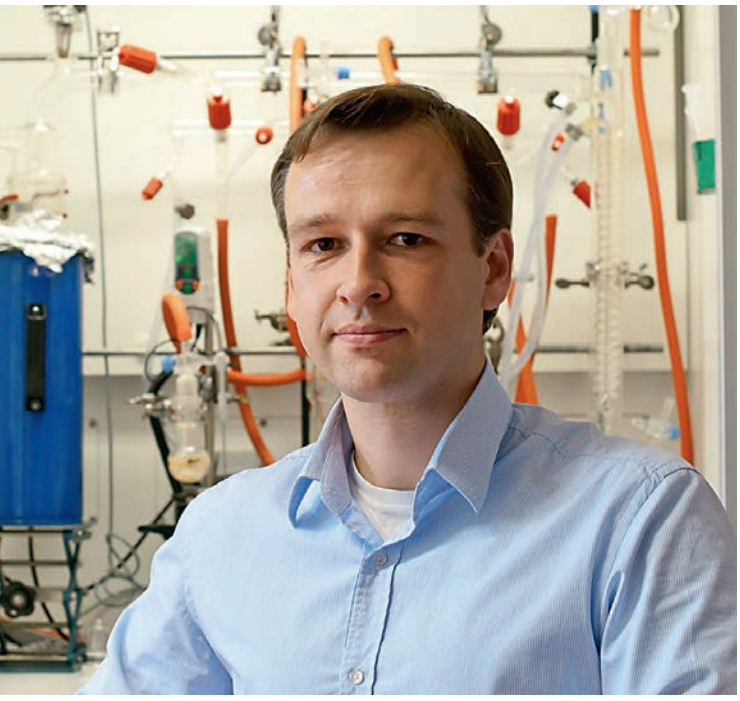
Catalysis without Conversion of Substances

Vectorial catalysis enables ion transport via membranes

At first sight there seems to be no obvious connection to catalysis: "Our research deals with the sensory photoreceptors of green algae and particularly with the question of how algae orient themselves in the light. These photoreceptors are microbial rhodopsins, similar to the rhodopsins in the human eye," says Professor Dr. Peter Hegemann, Professor of Experimental Biophysics at Humboldt-Universität zu Berlin and a UniCat member. This photoreceptor is a light-activated ion channel that enables photo-induced, vectorial catalysis. Whereas ordinary catalysis is all about the conversion of substances, vectorial catalysis enables the transport of substances in a certain direction: "These light-induced ion channels facilitate the transport of ions through membranes. The high resistance against this transport is overcome by these ion channels by means of creating a kind of transient, light-induced hole in the membrane, which enables the transport of sodium ions into, and potassium ions out of, the cell," explains Professor Hegemann. "Initially, my chemist colleagues did not even accept this as catalysis, because no substances are converted in the process," says the trained chemist with amusement. "Only step by step did it become a generally acknowledged fact that these processes are a type of catalysis, too."

In the course of the UniCat project, Professor Hegemann's research group concerned itself intensively with the molecular fundamentals of these channels, analyzing them both biochemically and – in cooperation with other UniCat groups – spectroscopically. Following this, they were able to produce different variants of these channels with the aid of molecular genetics, thus understanding the channels' functional principles better and broadening the scope of application. In this way, ion channels with a deviating color absorption spectrum

imize the functionality



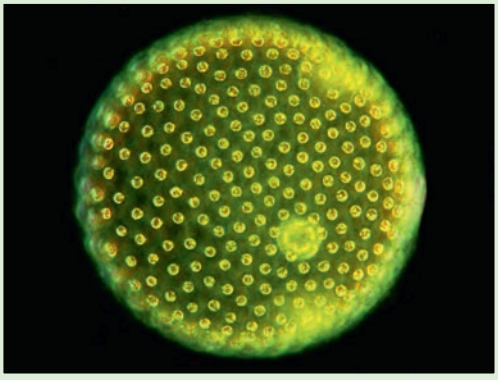
mas' research group is the generation of nanostructured materials for catalysis

groups is particularly important: the biological-chemical research groups are responsible for clarifying the structure and functional principles of promising enzymes. Research groups oriented towards synthetic chemistry endeavor to generate and test molecular models of these catalytic centers, while the material chemists use these molecules as starting points for developing stable solids.

"In the context of UniCat, we have been able to develop various efficient catalysts for the generation of oxygen and hydrogen from water. The challenge for my research group lies, among other things, in the generation of such materials not by means of conventional high-temperature methods, but rather by building them with great structural precision from their molecular precursors," says Professor Thomas.

In future scientists will be focusing, among other things, on combining these catalysts with semiconductor-based photocatalysts in such a manner that they function in the system and enable an efficient splitting of water by means of solar light.

"The combination of the individual components is anything other than trivial in this regard, since to achieve an efficient overall reaction the transport of materials, energy and charge carriers in these systems must be configured in a targeted manner," says Professor Thomas.



Dr. R. Wagner

The investigated photoreceptors originated, among other sources, from the Volvox algae which react to light with movement

or deviating kinetics (faster or slower than the original channel) were developed.

"At first appearance, this research into the so-called channel rhodopsins had no application-related benefit whatsoever," recalls Professor Hegemann. In 2005, however, it emerged that these light-sensitive channels are an excellent analytical tool in Neurophysiology. This means that these ion channels established the completely new scientific field of optogenetics. "For this purpose, the DNA of neuronal networks is transfected by means of a viral vector with the DNA of such photo-sensitive ion channels and coupled to a cell-specific steering element, a so-called promoter. In this way, these ion channels are developed in the target cells only. By means of this method, it became possible for the first time to turn nerve cells on and off using light pulses. This makes it possible to monitor connections or nerve fibers in neural networks," says Professor Hegemann, referring to the applications of his research for which he received the Berlin Award for Science in 2015.

Meanwhile, neurophysiologists all over the world, including Berlin-based colleagues from the Cluster of Excellence Neurocure, work with these ion channels.

"In the future, we will focus more on light-induced enzymes, that is, enzymes that carry out 'genuine' catalysis," says Professor Hegemann. "In this connection, we are not only interested in how the photoreceptors enable the activation of the actual protein, but also in the effect that can be achieved by means of coupling several of these catalysis units, that is, system catalysis (UniSysCat)."

KATHARINA JUNG

Learning from Nature

Why the structural analysis of enzymes is of interest to chemists, too

Almost everyone knows the oxyhydrogen reaction from Chemistry class at school, that is, the combination of hydrogen and oxygen to water and energy. "From a catalytic standpoint, this simple reaction is quite complex. Some bacteria use it to produce energy, but the catalytic mechanism has yet to be understood," says Dr. Oliver Lenz, a biologist researching at Technische Universität Berlin and member of the Cluster of Excellence UniCat. "In nature, this step is carried out by particular enzymes, the so-called hydrogenases. Most of these hydrogenases only work under anaerobic, that is, oxygen-free conditions. We are researching four different hydrogenases from the hydrogen-oxidizing bacteria Ralstonia eutropha, all of which are oxygen-resistant. Our special expertise lies in the biological activation of hydrogen by means of these hydrogenases, which is a very interesting process for industry."

Dr. Lenz and his research group focus on the purification and biochemical characterization of these enzymes. In order to understand its functional principle, it is crucial that the enzyme is available in homogeneous form, that is, in a uniform, natural and, above all, catalytically active Condition.

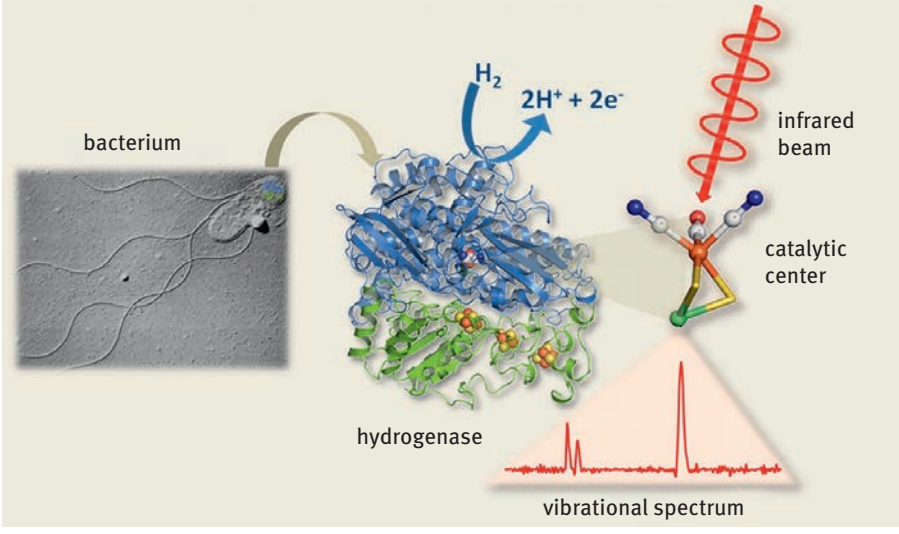
All four hydrogenases were purified and analyzed

„In cooperation with the research groups of Dr. Patrick Scherer at Charité and Professor Dr. Holger Dobbek at Humboldt-Universität zu Berlin, we were even able to determine the exact crystal structure of two of the hydrogenases. In this way, we have learned a lot about the functional principles and the importance of individual structural elements." The crystal structure shows the 3D architecture of a protein as detailed as the atomic structure. In this case, the crystal structure of one of the hydrogenases had a surprise in store for the scientists: "Time and again, we asked ourselves in what way the catalytic center of this hydrogenase differed from that of oxygen-sensitive hydrogenases. The crystal structure revealed that the difference does not in any way lie in the catalytic center, but rather directly next to it, in the so-called iron-sulfur clusters that are important for the electron transport within the enzyme," says Dr. Lenz.

In cooperation with a further UniCat partner at TU Berlin, Professor of Biophysical Chemistry Peter Hildebrandt, these enzymes were examined in living cells by means of vibrational spectroscopy. For this purpose, the substances are irradiated with light of certain wavelengths, thereby showing characteristic vibration spectra that provide evidence about the catalytic mechanism.

"Although we now know the molecular fundamentals of the enzyme, we still need to find out how exactly the hydrogen splitting takes place. Chemical models can be a great help in this regard," says Dr. Lenz. These models are provided by UniCat partner Professor Dr. Matthias Drieß, Professor of Metalorganics and Inorganic Materials at TU Berlin. This is an example of how biological and chemical research are becoming fused.

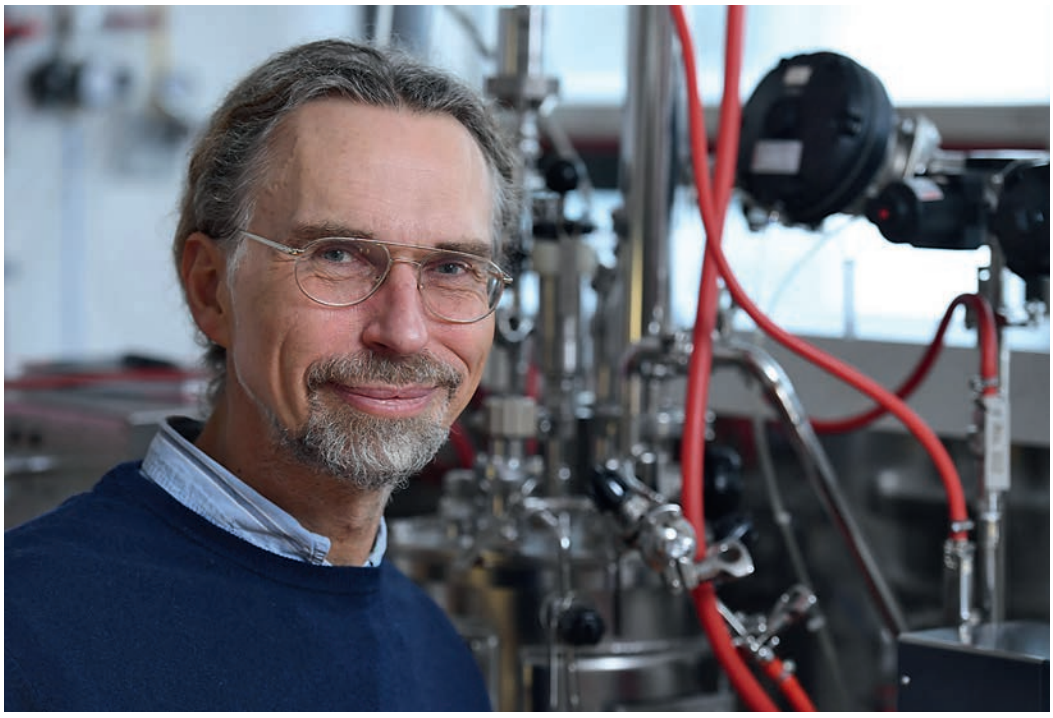
KATHARINA JUNG



TU Berlin/UniCat

The molecular fundamentals of the catalytic centers could be elucidated for two out of four enzymes (hydrogenases) obtained from bacteria. Significant results were gained by means of vibrational spectroscopy of enzymes in living cells

David Ausserhofer



„Understanding every step of the catalytic reaction is important“, says Prof. Holger Dau

Wanted: Catalysts for Artificial Photosynthesis

Searching for catalysts that do not require precious metals

For years, we have been investigating enzymatic water splitting in photosynthesis," says Professor Dr. Holger Dau, Chair of the subject area of Biophysics and Photosynthesis at Freie Universität Berlin and a UniCat member: "In doing so, we have been particularly interested in the manganese-calcium cluster that forms the active catalytic center of the enzyme. While, in recent years we have been able to characterize the biological system rather well, in the context of UniCat we are engaged primarily in research into so-called synthetic catalysts, that is, inorganic replicas of the biological catalytic center. This mostly pertains to metal oxides that also have catalytic effects."

The long-term goal is so-called artificial photosynthesis, that is, the use of solar energy for the production of various non-fossil fuels, and particularly hydrogen. For this purpose, water and carbon dioxide serve as the sole raw materials, just as in biological photosynthesis. The main problem in the development of efficient catalysts for artificial photosynthesis is to avoid the use of rare precious metals.

"Whereas biological enzymes use sunlight as energy as energy source, we apply synthetic catalysts onto an electrode, in the form of a film, and trigger the catalytic process of water splitting by applying voltage," Professor Dau explains. The close cooperation with UniCat partners who occupy themselves primarily with the synthesis of molecules enables the research into greatly varying metal oxides, from which much can be learned about the optimal structure and selectivity of a catalyst. "The goal in this regard is not only to find out which structure is more effective, but, above all, why this is so," says Professor Dau.

Understanding is of paramount importance

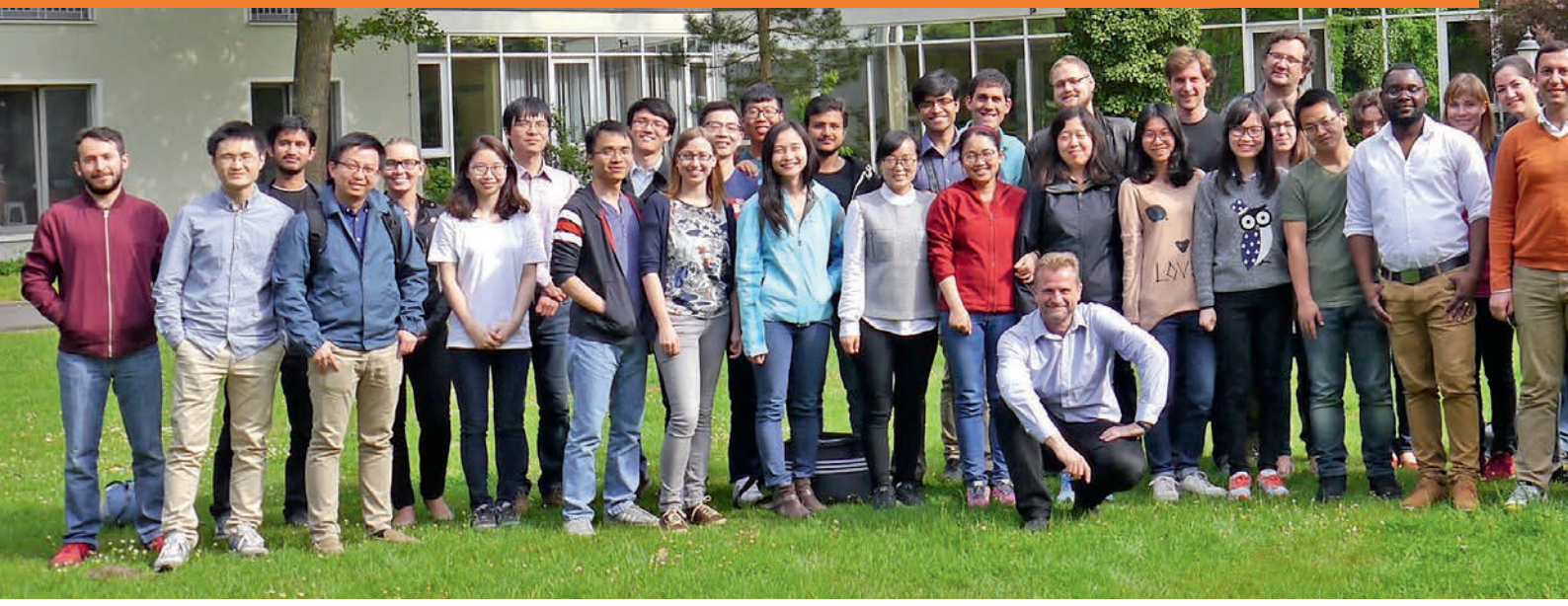
His research group has exactly the expertise required for such research. "We investigate these reactions at the metal centers particularly by means of X-ray spectroscopy at the BESSY (Berlin Electron Storage Ring Society for Synchrotron Radiation). This method is able to elucidate the exact atomic structures of non-crystalline materials – at least to such a degree that helpful structural models can be built on their basis," says Professor Dau. "A further advantage is that we can measure the reaction there in situ – that is, at the very moment it is taking place."

As a result, the scientists already know a number of very good catalysts for splitting water in the alkaline range. "However, for many technical processes one would rather have this splitting take place in a neutral pH range. The appropriate catalysts for this purpose have yet to be found," says Professor Dau. "At least we were able to analyze why this is the case. Now we need to focus on finding solutions."

KATHARINA JUNG

Working together for Research

The BIG-NSE educates young scientists and moreover, makes team players of them



Workshops and joint research camps are part of the BIG-NSE concept. They strengthen the sense of community and promote interdisciplinary exchange

There is something truly special about writing a doctoral thesis at the BIG-NSE. Dr. Jean-Philippe Lonjaret, Managing Director of the Berlin International Graduate School of Natural Sciences and Engineering, is convinced this is true. The Graduate School's doctoral candidates have one great advantage over other doctoral candidates: they research and write their doctoral theses together as a community.

In 2007, the BIG-NSE was initiated as part of the Cluster of Excellence UniCat with the goal of attracting highly qualified young scientists who would all work together on the same topic, namely, catalysis. "Catalysis plays a central role in many different production processes in industry", says Dr. Lonjaret, thereby indicating the broad range of research topics conducted interdisciplinarily at the BIG-NSE by scientists from the fields of Chemistry, Biology, Biochemistry, Chemical Engineering and Materials Sciences.

privat

Dr.-Ing. Jean-Philippe Lonjaret, Managing Director of the BIG-NSE

Six institutions offer a high-quality educational program under a single roof: the three Berlin universities (Technische Universität Berlin – host university, Humboldt-Universität zu Berlin and Freie Universität Berlin), the University of Potsdam, the Fritz Haber Institute of the Max Planck Society and the Max Planck Institute of Colloids and Interfaces. "We pool the expertise of the different institutions and subjects."

Currently, 50 doctoral candidates, including some with a UniCat scholarship, are carrying out research at the Graduate School. Life under the roof of the "Villa Bell" on TU Berlin's campus is international and colorful. 76 percent of the young scientists come from abroad, many of them from China, India and South America. 40 percent of the scientists are women. "Gender equality is very important to us," says Dr. Lonjaret, "also when it comes to awarding scholarships". Each year, around 150 women and men

TU Berlin/UniCat/Martin Penno

Berlin International Graduate School of Natural Sciences and Engineering

FACTS AND FIGURES

The BIG-NSE has trained a total of 123 scholarship holders, including 58 with BIG-NSE Scholarships (21 current, 37 completed). A further 65 Graduate School members hold different scholarships, for example from the DAAD

Completed Doctorates since 2007: 73, 92 % of which were rated "excellent" or "very good"

Awards for excellent doctoral theses: 8

Awards for lectures and posters at conferences: 14

Further international awards, including one EXIST Business Start-Up Grant: 6

Scholarships for conferences, summer schools, international research stays: 18

76 % of all current doctoral students are from abroad (alumni: 60 %

40 % of all current doctoral students are female (alumni: 42 %)

The average period of doctoral studies is 4.1 years

32 (45.7 %) of the alumni occupy positions as post-doctoral researchers or work as project leaders at a university

3 (4.3 %) of the alumni have been appointed professors

2 (2.9 %) of the alumni work in the field of knowledge management

23 (32.9 %) of the alumni work in private research & development

5 (7.1 %) of the alumni work in the private sector (for instance in a startup or as a teacher)

5 (7.1%) of the alumni are currently seeking work

apply for the three-year grant, of whom 15 are invited for an interview, with four of them later receiving a scholarship.

Those accepted to the BIG-NSE become members of a large research family. The Graduate School always starts in October. The first three months, also termed the initial phase, are intended for people to get to know each other. Women and men cook together, watch movies, play soccer, go on bicycle tours or play table soccer in the common room. However, this is also the phase in which they gear themselves up for the approaching doctoral thesis. Since all doctoral students are required to choose two supervisors preliminary lectures are held to help the candidates become acquainted with the professors from the different subject areas. Here, chemists listen to the lectures of biologists, physicists to the lectures of biochemists. Excursions to various laboratories enable doctoral students to complete the picture that they need to form of the interdisciplinary world of the BIG-NSE, where they will eventually have to find their own place. One excursion brings them to the BasCat laboratory, a joint project by UniCat and BASF that was initiated in 2011 with the goal of developing new catalytic processes for the raw material change that promotes the search for alternatives to petroleum in the foreseeable future.

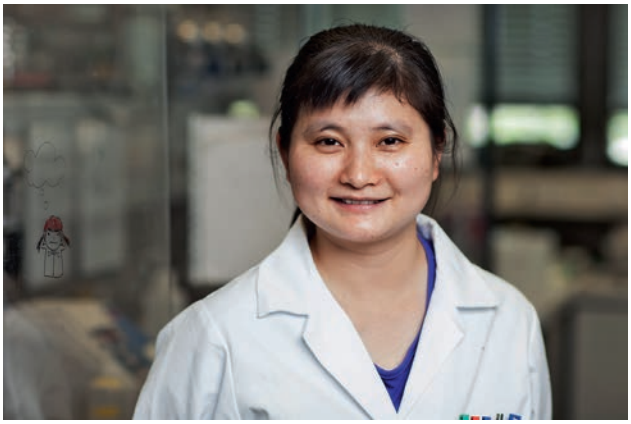
At the end of the initial phase, the doctoral students present their project plans to the UniCat members, indicating how they intend to spend their years at the BIG-NSE. Once they have gone through this baptism of fire, they go to their respective research groups and begin their work. "What is really great is that they can ask their colleagues for advice at any time and continue to work together," says Dr. Lonjaret. That the interdisciplinary approach bears fruit is evidenced by the fact that many of the publications involve the work of several doctoral candidates.

And what happens after their years spent at the BIG-NSE? "All doors are open to those who successfully complete their Doctorates," says Dr. Lonjaret. Some go into industry, while others stay in higher education, either as project leaders or on the path to professorship. Dr. Lonjaret also knows a graduate who became self-employed after founding his own startup in Berlin. The Graduate School prepares young scientists for a wide variety of challenges.

DAGMAR TRÜPSCHUCH

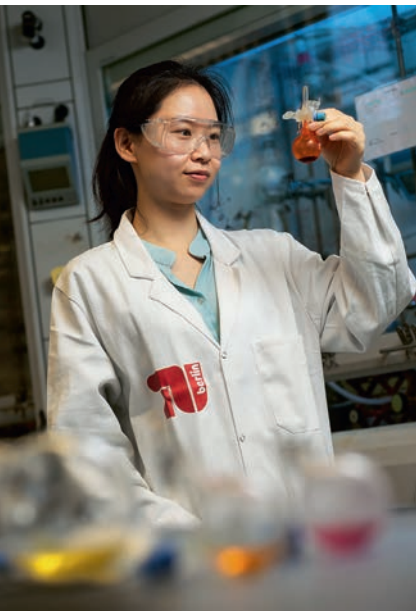
BIG NSE Scholarship Holders

Fang Luo CHINA



Fang Luo comes from China. In 2009, she completed her Master's degree at the Harbin Institute of Technology (HIT). The HIT is part of the C9 League, an alliance of nine elite Chinese universities. After her studies, she gained five years' work experience in the fields of technology and materials sciences.
Then she felt the desire to work more scientifically again. "I wanted to do something more challenging and diverse," says Fang Luo. Via the Internet she discovered that the BIG-NSE would be presenting itself at a conference in Beijing. There she met JP, as Dr. Jean-Philippe Lonjaret is affectionately known among Graduate School members. Equipped with a scholarship from the China Scholarship Council (CSC), she joined the research group of Professor Dr. Peter Strasser.
In her research she concerns herself with catalysts for oxygen-reducing reactions. In particular, she is trying to replace the expensive precious metal platinum with transition metals such as iron, cobalt or tin, thereby making catalysts cheaper and, ideally, more efficient, too.

Min Ha Kim SOUTH KOREA



Min Ha Kim studied Chemistry at the Seoul National University in South Korea. In her Bachelor's and Master's theses she was particularly interested in the synthesis of precious metal complexes. "For me, synthetic chemistry is like building with Lego bricks. It is a unique feeling to have synthesized something that has never existed before," says Min Ha Kim. She became interested in studying in Germany, gathered together all the available information, and participated in a job fair in Seoul organized by the German Academic Exchange Service for prospective doctoral candidates, where the BIG-NSE presented itself, too. The opportunity to develop her chemical knowledge further as part of the specialized research cluster UniCat appealed to Min Ha Kim. She quickly found her topic and the corresponding research group. "The program looked interesting, because it was very well-structured," she says.
Min Ha Kim decided to apply and now works in the research group of UniCat spokesman Professor Dr. Matthias Drieß. Her research deals with silylene ligands for the synthesis of precious metal catalysts. The three-month initial phase with lectures held by UniCat professors helped her to understand the UniCat concept. "We learned about the latest research results and future challenges," says Min Ha Kim.

Huan Wang CHINA

"Well, the BIG-NSE was my first choice," says Huan Wang from China. "I wanted to write my doctoral thesis in a large city – and chemical research is great in Germany." For him, Berlin is particularly attractive because of its high density of universities and research institutions.
After having met JP – that is, BIG-NSE Managing Director Dr. Jean-Philippe Lonjaret – in Beijing in 2013, Huan Wang successfully applied for a BIG-NSE scholarship and then contacted his future supervisor. Now he is working in the research group of Dr. Ralph Krähnert, concerning himself with catalysts for the oxidative coupling of methane to ethylene. He focuses particularly on porosity and the composition of catalytically active materials. His experimental research also benefits from the close cooperation with the Leibniz Institute for Catalysis (LIKAT). Huan Wang can only say positive things about the initial phase, the three-month program for all first-year students at the BIG-NSE: "The excursions to the laboratories of other UniCat research groups in Berlin and Potsdam were especially important." In the German classes he not only learned something about Germany, but also about the German lifestyle.

Ongey Elvis Legala CAMEROON

Elvis Legala initially studied Biochemistry at the University of Bea in Cameroon. For his Master's studies he changed to the University of Oulu in Finland, where he occupied himself with proteins and biotechnology. He came to TU Berlin with an Erasmus Mundus scholarship that enabled him to complete his Master's thesis here.

"I find the intenseness, the high quality and the interdisciplinary approach of the BIG-NSE doctoral program extremely agreeable," says Elvis Legala. "My current research focuses on the production and characterization of natural, anti-microbial peptides." Elvis Legala cooperates with different research groups at TU Berlin, for instance with Professor Dr. Roderich Süssmuth's UniCat group, as well as with Einstein Professor Juri Rappsilber from the Department of Bioanalytics.

The structured initial phase was an excellent bridge for him, because it not only increased intercultural awareness among the BIG-NSE doctoral students, but also allowed them insights into the rich experimental equipment at the UniCat cluster and demonstrated opportunities for cooperation.

Felix Pape BERLIN

Felix Pape studied Chemistry at TU Berlin and spent part of his Master's studies in the USA, where he did a research internship. After successfully completing his Master's thesis, he began his doctoral studies as BIG-NSE scholarship holder with Professor Dr. Johannes F. Teichert.

Asked why he applied to the BIG-NSE of all institutions, he answers: "I found the integration into the UniCat network and the collaboration between different research branches particularly attractive."

Felix Pape works in the field of organic chemistry, his topic being the development of innovative methods for the catalytic activation of hydrogen (H_2). "The goal is to use this environment-friendly gas in chemical reactions and therefore reduce the production of chemical waste," he says.

The international UniCat network provides him with many useful contacts and allows him to work in an international team – something which is of crucial importance for him. He plans to finish his doctoral thesis over the next few months.

Photos: TU Berlin/Christian Kielmann

Rhea Christodoulou HAMBURG

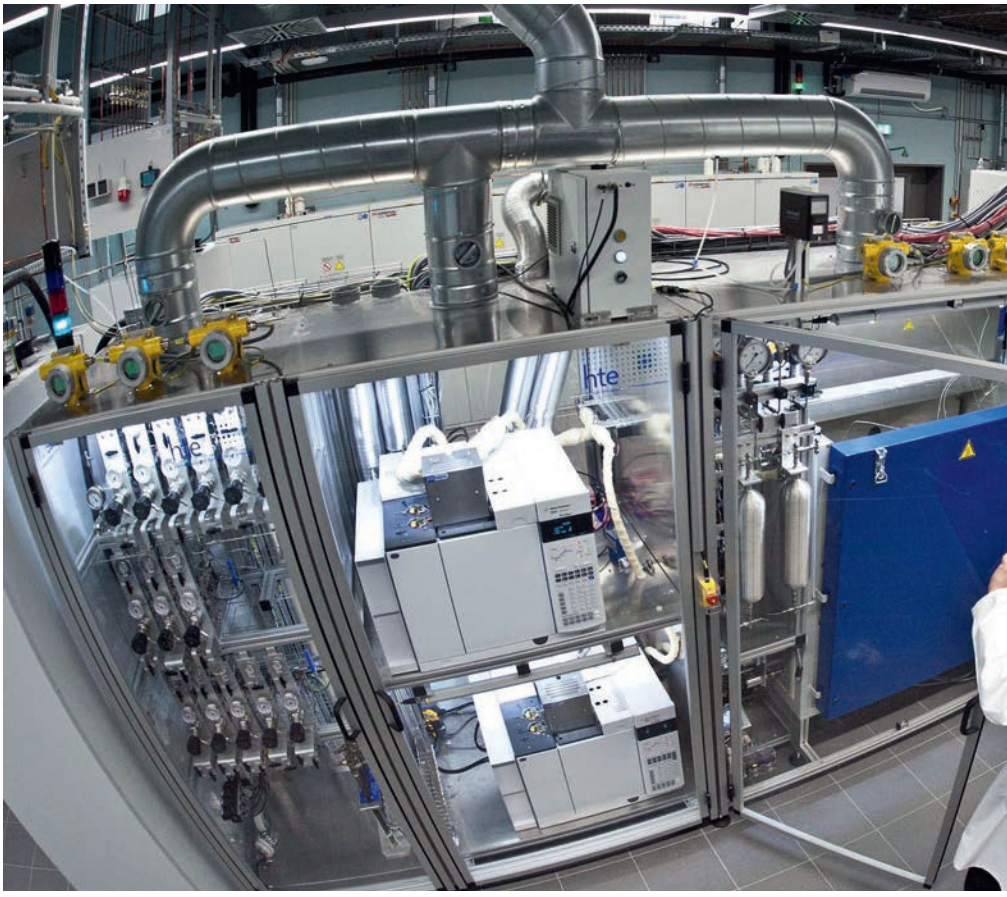
Rhea Christodoulou, a child of Europe with roots in northern Germany and northern Greece, grew up in Hamburg and studied Process Engineering at the Hamburg University of Technology (TUHH). She wrote her Master's thesis at the university's Institute of Chemical Reaction Engineering under the supervision of Professor Dr. Raimund Horn, a former leader of a UniCat junior research group.She had many reasons for applying to the BIG-NSE. "For one, it is a great opportunity for networking. In addition, I find it very attractive to be given the chance, as a new member of TU Berlin, to get to know the different research groups of the UniCat cluster," says Rhea Christodoulou.

She is writing her doctoral thesis about selective oxidations of alkanes and their investigation by means of kinetic and spectroscopic profile measurements in a fixed-bed reactor at the BasCat, a JointLab operated by UniCat and BASF.

The exchange with her BasCat colleagues is having a great impact on her work. "Whereas many of my colleagues are chemists, I am an engineer. The different perspectives enrich the discussions and broaden the horizons," she enthuses and adds: "My BIG-NSE class continues to meet once a week and we regularly exchange views about our research."

Scientific Curiosity Wanted

At BasCat, basic research and application-oriented research complement each other



At the BasCat laboratory, scientists not only have access to the UniCat research network, but also gain important insights into industrial research

We take on the challenges that others have not yet solved – the hardest nuts of heterogeneous catalysis research," says Dr. Frank Rosowski of BASF, one of the three scientific directors of BasCat, describing the mission set for the JointLab of BASF and UniCat. The other two directors are Professor Dr. Matthias Drieß of Technische Universität Berlin and Professor Dr. Robert Schlögl, Director at the Fritz Haber Institute. Founded in 2011 and launched on TU Berlin's campus in 2014, the laboratory rooms currently provide a working environment for seven postdoctoral researchers, eleven doctoral students and several Master's students. BASF, TU Berlin and UniCat have invested around 13 million euros in the equipment and operation of the laboratory and office premises that take up around 1,000 square meters of the Campus Charlottenburg. In late 2016, the contract was extended by a further five years until the end of 2021.

"Catalysis has been investigated for more than a century. Groundbreaking new catalysts, as developed in the chemical industry – for instance by means of systematic synthesis and the testing of thousands of materials in high-throughput processes – are hardly to be found these days," says Dr. Rosowski.

BASF and UniCat benefit on several levels

„We want to generate in important fields completely new knowledge that leads to a breakthrough in the selective activation of small and inactive molecules. This can only be achieved by means of innovative basic research, in conjunction with scientific curiosity and a continuous, long-term partnership. BasCat researchers not only have access to the UniCat research network, but also gain important insights into industrial research. In addition, the doctoral education at BasCat is excellent. This is of interest not only to the university but also to us as a company."

The goal at BasCat is to activate the basic building blocks of natural gas such as methane, butane or propane in such a manner that they are directly convertible into industrially utilizable intermediate products. There are no efficient catalysts for these reactions. "At BasCat, our starting point is always the understanding and analysis of working catalysts under reaction conditions, until we have understood the mode of action. By means of the profile-reactor technology, which has been further developed here, we can analyze, for instance, 'in situ' – that is, live at different locations in the reactor – catalytic processes under conditions close to those found in industry. A further focus is on design patterns for the synthesis of new materials. This is often impossible when applying established synthesis methods. For example, atomic layer deposition (ALD) is specifically used for the surface modification of catalysts. You need the combined know-how of researchers from both academia and industry to achieve such developments and build the special equipment," says Dr. Rosowski. ▶ KATHARINA JUNG

TU Berlin/Jacek Ruta

Entrepreneurial Offensive in Green Chemistry

The Inkulab provides young entrepreneurs with free laboratory space

Not every young scientist educated at UniCat sees his or her future in a purely scientific world. Some of them change to major corporations, while others contemplate founding their own businesses. But: "Many great ideas from natural scientists do not even make it as far as the stage of practical application, because the necessary infrastructure is lacking. Young inventors must be given the chance to use their fresh ideas and establish their own businesses within the protection of a creative cocoon," says Professor Dr. Matthias Drieß, spokesman of the Cluster of Excellence UniCat. A company associated with green chemistry or the life sciences cannot be founded in the kitchen or in a trendy café, because expensive laboratory space and equipment is required. It was just this gap that was closed in late January by the Inkulab, a joint project by Wista Management GmbH, TU Berlin's Centre for Entrepreneurship and Cluster of Excellence UniCat in cooperation with DexLeChem GmbH.

For this purpose, a green laboratory container, fully equipped with ventilation, laboratory furniture and safety devices, was set up on TU Berlin's premises in direct proximity to UniCat, providing entrepreneurs from the fields of Chemistry, Life Sciences or Nanotechnology with free laboratory workstations and a startup incubation program. Three startups from Berlin-based universities are already using the Inkulab program, others will follow. The proximity to the scientific community is a crucial factor in this regard: "A structure like this will not work on a greenfield site anywhere. 60 percent of all German startups in the field of Chemistry are already based in Berlin, because the local universities produce excellent graduates and some of the staff from Berlin universities offer valuable assistance during the incubation phase. This intellectual environment is crucial for the startups," says Professor Drieß. UniCat Professor Dr. Reinhard Schomäcker from TU Berlin's Department of Chemistry is equally convinced of this: "Apart from the laboratory equipment, the worth of the workstations lies above all in their proximity to the Department of Chemistry. The 'stand-alone building' ensures the visibility of the startups."

TU Berlin/Philiip Arnoldt

The Inkulab container on TU Berlin's premises provides start-ups with laboratory equipment which they could not otherwise afford

"The Inkulab is a good start. However, we are thinking ahead: In the coming years, the field of green chemistry will experience enormous changes, not least due to environmental regulations and the exhaustion of fossil energy sources. This offers many opportunities for young entrepreneurs specializing in sustainable production, that is, in the production of chemical products that avoid as far as possible the generation of hazardous byproducts. For this reason we are planning a large entrepreneurial center, the so-called Chemical Invention Factory (CIF). The Berlin Senate has already approved a very large sum for the funding of an appropriate new building on TU Berlin's premises," says Professor Drieß.

KATHARINA JUNG

“More money does not automatically mean better research”

Professor Gerhard Ertl, Nobel Laureate in Chemistry, on alchemy, catalysis research and the popularity of scientists

Despite the fact that Professor Dr. Gerhard Ertl is originally a physicist, he was awarded the Nobel Prize in Chemistry for his groundbreaking research into chemical processes on solid surfaces in 2007. He ranks among the founding fathers of modern catalysis research. The Swabian, who studied in his hometown of Stuttgart as well as in Munich and Paris, began his career as a professor in Hanover and Munich; he also worked on and off as a visiting professor in the USA. In 1986, he was appointed Director of the Department of Physical Chemistry at the Fritz Haber Institute of the Max Planck Society in Berlin. Professor Ertl, an Honorary Member of TU Berlin, is regarded by many as the “guiding spirit” behind the UniCat cluster, not least because a considerable proportion of the research conducted at UniCat is based on his work. On the site of the Cluster of Excellence UniCat at TU Berlin’s Campus Charlottenburg his name has been given to UniCat’s main building, which opened in 2012 as the Gerhard Ertl Center.

TU Berlin/Oana Popa

Professor Ertl, as someone with expert knowledge of the scientific community in Berlin, how strong was the sense in 2007 that the establishment of UniCat was on the cards?

Gerhard Ertl: During my working years, various cross-connections existed between scientists at the Berlin universities and – for example – those at the Fritz Haber Institute. They knew each other and also engaged in various exchanges. Among other things, there was a very successful collaborative research center dealing with catalysis, although it had not been conceived as a fully interdisciplinary institution. It was almost obvious that this type of research needed to be pooled, in one way or another, in an institution such as UniCat.

Where do you think the greatest successes of the cluster lie?

The greatest success was that scientists from different disciplines, that is, biologists, chemists, physicists and engineers, were brought together and had to communicate with each other. I am reluctant to emphasize any individual topic, since I believe that the greatest success lies in the synergy effects generated by this cluster.

When I began devoting myself to the topic of heterogeneous catalysis, it still had about it a sense of alchemy – the black art. Researchers only had a faint idea of what was actually going on. That was also the reason why I was so fascinated by it back then. However, thanks to UniCat and other similar institutions, those days are over. Although we are not yet able to answer every question, we know the fundamental laws according to which processes take place.

If you could choose a research topic today, would it be catalysis again?

If I had to start all over again today, I would probably tend more towards the field of Biophysics, since this is currently the area with the exciting problems. The interaction of different individual processes within a cell functions in an unbelievably efficient manner – although we do not yet know in detail how and why this is the case. The essential and exciting questions for future research lie in this coupling of processes. How do different systems interact in a resource- and energy-saving manner? How can these processes be steered in a certain direction? This type of research requires an even greater interdisciplinarity on the part of the scientists. I am convinced that Biology will strongly inspire Chemistry over the coming years.

On the one hand, a high degree of subject-specific expertise is required, on the other hand, interdisciplinarity. How do these go together?

As the individual natural sciences constantly develop, the sciences will grow together afresh even more – this applies, in particular, to the border areas between individual subjects. Universal scientists such as Gottfried Wilhelm Leibniz will not be making a comeback, because subject specialization is now way too advanced. However, it will be increasingly important for scientists from different disciplines to use a common language.

TU Berlin/Ulrich Dahl

Science meets music – music meets science: on the occasion of his 78th birthday in 2014, Gerhard Ertl (rightmost) gave a concert at TU Berlin's main auditorium before an audience of 1,000 guests

How important is a large, well-equipped location such as a Cluster of Excellence for securing success and visibility on an international scale?

It is absolutely right and essential to support good scientists by means of such a funding instrument. But the sequence is crucial: good research is international of its own accord. A good scientist automatically develops international contacts and attracts further good scientists. I have always refused to accept the notion that more money automatically leads to higher-quality research. Anyone with a good idea will also find support in Germany.

Nowadays, we sometimes encounter a denial of objective scientific findings and discussions about post-truths. Where do you see the responsibility of scientists in this regard?

It is extremely important that the sciences articulate themselves and clearly point out that, while some questions naturally remain unanswered, there are also findings which are not subject to opinion and which cannot merely be argued away or ignored. This was the reason for the March for Science, which I welcomed very strongly. Science is financed by society, and therefore it is absolutely essential that it also steps out into the public arena. The mere publication of a scientific truth is not enough; it has to be sold, too. Unfortunately, German scientists are still a little reserved in this regard.

Before you received the Nobel Prize, you had already won several renowned international awards. Why is it that your achievements were only noticed by the wider public once you received the Nobel Prize?

The Nobel Prize brought me a certain celebrity, not so much for my scientific work, but for me as a person. In that year, according to a survey carried out by a daily newspaper, I was the second most popular Berliner – Number One was the zookeeper who looked after Knut the polar bear cub. This just goes to show that when it comes to a Nobel Prize the public's interest has more to do with celebrity obsession than with science.

▶ THE INTERVIEW WAS CONDUCTED BY KATHARINA JUNG

10 YEARS ... ... Statements

Beyond Borders

Prof. Dr. Christian Thomsen
President of TU Berlin

David Ausserhofer

On the tenth anniversary of its foundation we look with very special pride at "UniCat", TU Berlin's only Cluster of Excellence. We are not only proud of the many scientists who over the last ten years have generated so many new research discoveries in the important field of catalysis. What marks out this cluster in particular is also the strong cooperation with other university and non-university partners. UniCat has developed its own brand and thereby achieved an international reputation. Countless publications and patents, as well as a growing number of international researchers who for long or short periods were or are UniCat members, demonstrate the ever growing value that has arisen from such a great union of researchers. Among other things, BasCat, a new research laboratory, was founded jointly with BASF; the Graduate School BIG-NSE is providing excellent young researchers; and many members have already accepted professorships at other universities. With the "Inkulab", which was opened on campus at the beginning of 2017, we were able to make another significant step forward in the area of founding new companies. This was both strongly supported by politicians and also greatly appreciated by the public.
I thank all those who have taken part, and are taking part, in managing this grand project, who have made it shine brightly in Berlin and far beyond, who ensure that new scientific discoveries are constantly emerging – beyond the boundaries of subjects and institutions.
Congratulations, UniCat!

The Freedom to Act

Dr. Subhamoy Bhattacharya
Research Engineer, Chemical and Process Engineering, BASF SE

private

From 2008 until 2011. That encompasses my time as an active member of UniCat holding a scholarship from BIG-NSE. When I reflect upon this period, I feel very strongly that the years I spent as a member of the UniCat family have contributed in an immensely comprehensive way towards shaping my life and career. From the provision of the opportunity to work with very talented scientists in the field of catalysis, to the freedom to act in a way that enabled me to experience interdisciplinary research, to the stimulating discussions that I had with the best professors in my area of study. All of this took place in the heart of one of the world's most culturally rich capitals, that is, in Berlin! In those years, UniCat was a powerful "catalyzer" for my own personal growth. Best wishes on your tenth birthday, UniCat!

Productive Synergies

Dr. Anna Company Casadevall, Grup de Química Bioinspirada, Supramolecular i Catàlisi (QBIS-CAT), Institut de Química Computacional i Catàlisi (IQCC), Departament de Química, Universitat de Girona

private

Thanks to the Clara Immerwahr Award I was able to begin a very successful collaboration with the group of Professor Kallol Ray at the Humboldt-Universität zu Berlin. As a result, one of my PhD students at the University of Girona (Catalonia, Spain) was invited to Berlin for a four-month research stay. This went on to form the basis for a very challenging project. What I appreciate especially about the Clara Immerwahr Award is that it initiates collaborative projects from which, in turn, very productive synergies develop. The Clara Immerwahr Award constitutes a significant milestone in my research career. In one way or another it opened new doors for me into the world of research. Even today I still remember with great emotion the award ceremony at TU Berlin in February 2015 organized by UniCat. It was a superb event!

TU Berlin/Christian Kielmann

Valuable insights

Claudia Nasrallah, Gender Equality Coordinator, UniCat

The issue of gender equality in science has been a matter of special concern to me for many years and is something I constantly pursue with dedication and stamina. When, in 2008, I received the opportunity to take up the post of Gender Equality Coordinator at UniCat it was for me a very exciting and structurally new area of responsibility. Previously, as women's representative, I only had to keep an eye on one faculty, whereas here I have had to develop and coordinate measures that are equally interesting and promising for female scientists from different disciplines and several institutions. Additionally, in 2009, I became an executive assistant to the management board. As a business economist, I find the associated tasks enormously attractive as well, because I gain not only valuable insights into the management of a major research partnership but also acquire very useful experience in the coordination of research proposals.

private

Successful cooperations

Professor Andreas Möglich, PhD, University of Bayreuth, Chair of Biochemistry

Around two years after my arrival at HU Berlin as Professor for Biophysical Chemistry it was a matter of tremendous joy, honor and opportunity in equal measure to be accepted with a sub-project into the UniCat research group D4/E4 in the second funding period. Facilitated by the financial support and material assistance on offer, we succeeded in creating a synthetic enzyme, activated by red light, that produced mechanistic insights and novel applications in Cell Biology. Parallel to this, I profited without question from the scientific environment offered by UniCat, within whose framework fruitful collaborations with my colleagues Professors Bittl and Budisa could be developed and deepened. I would also not have wanted to miss out on the very valuable moral support available, especially that which arose from interactions with other young scientists. Since April 2015, in my new position at the University of Bayreuth, I have been continuing the exciting discourse with chemists and their concepts cultivated within the framework of UniCat.

As others see it ...

Professor Douglas Stephan ...

...Professor of Chemistry at the University of Toronto, is a member of the Scientific Advisory Board of UniCat and was involved from the very beginning: „The members of UniCat's Advisory Board are internationally renowned experts in catalysis research. Our task, as I see it, is to keep an eye on the big picture for UniCat. You might lose sight of that if you are too deeply involved in everyday operations. The Advisory Board brings together expertise in catalysis research from all parts of the world. With this outside perspective, we hope to bring some good ideas and suggestions to Berlin - and we will also take something back with us."

As an internationally renowned scientist, he does not find it difficult to provide an assessment of ten years of UniCat in Berlin: „I see two main reasons for Unicat's international success: on the one hand the high degree of interdisciplinarity. Catalysis is by its nature, an interdisciplinary research area. This is implemented particularly effectively here in Berlin, where scientists from the fields of Chemistry, Biology, Chemical Engineering and various other research areas work together closely. From this approach, research results have emerged that would otherwise never have been possible. I have experienced this myself. I think the second success factor is the good exchange of ideas in a spirit of partnership with the chemical industry in Germany. That is not possible in many other countries."

private

Douglas Stephan considers the German approach of promoting excellent research in larger clusters to be the right one: „In Canada, we have been working for years to obtain comparable funds and support - so far without success." He thus finds it all the more logical to continue this work within the framework of UniSysCat in the Strategy of Excellence: „The approach of UniSysCat to investigate catalysis in larger systems is logical."

As an Einstein Visiting Fellow, Douglas Stephan spends several months in Berlin every year. There he cooperates very closely with the teams of Professor Matthias Drieß and Professor Martin Oestreich. In addition, he serves as co-advisor for two doctoral candidates from each group. The focus of his research is on the use of main group elements in homogeneous catalysis. His current research is based on a method he developed to activate hydrogen by a metal-free catalyst and use it in the hydrogenation of unsaturated organic groups. This work has been recognized as pioneering in catalysis research. For many years he has been influential in the field of molecular chemistry and his work has attracted international attention.

KATHARINA JUNG

10 YEARS ...
... Outreach

Long Night of Science



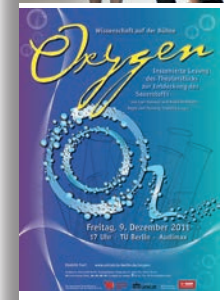


TU Berlin/press office/Ulrich Dahl; Krawczyk; UniCat

Open Day


TU Berlin/press office/Ulrich Dahl

Science on stage

Oxygen play November 2011

Insufficiency play (Killerblumen) December 2012


TU Berlin/press office/Jacek Ruta

Clara Immerwahr Award

The Clara Immerwahr Award, launched by UniCat in 2011, is conferred annually to a young female scientist from Germany or abroad at an early stage of her career (postdoctoral fellow, junior researcher) for outstanding results in Catalysis Research. It is associated with a financial support of 15.000 Euro for a research stay at UniCat and thought to establish close collaborative links with UniCat working groups.
The Award serves as an excellent exemplar of the promotion of outstanding young female scientists and is another successful measure taken by UniCat aimed at advancing female researchers.

2012

Dr. Kylie A. Vincent,
Oxford University, UK

2013

TU Berlin/press office/J. Ruta (4)

Dr. Jennifer Edwards,
Cardiff University, UK

Ertl Lecture

TU Berlin/press office/Ruta; Heyne

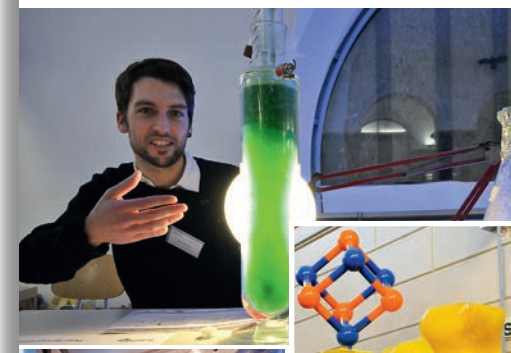
Openings

Formation of UniCat – Kick-off Meeting May 2008

BasCat 2014

Inkulab 2017

And a lot more



TU Berlin/press office/Ulrich Dahl, Jacek Ruta, Philipp Arnoldt; WiD/Hendel; David Ausserhofer

2014

Dr. Teresa Santos-Silva, Nova University of Lisbon, Portugal

2015

Dr. Anna Company, University of Girona, Spain

2016

private

Dr. Rebecca Melen, Cardiff University, UK

2017

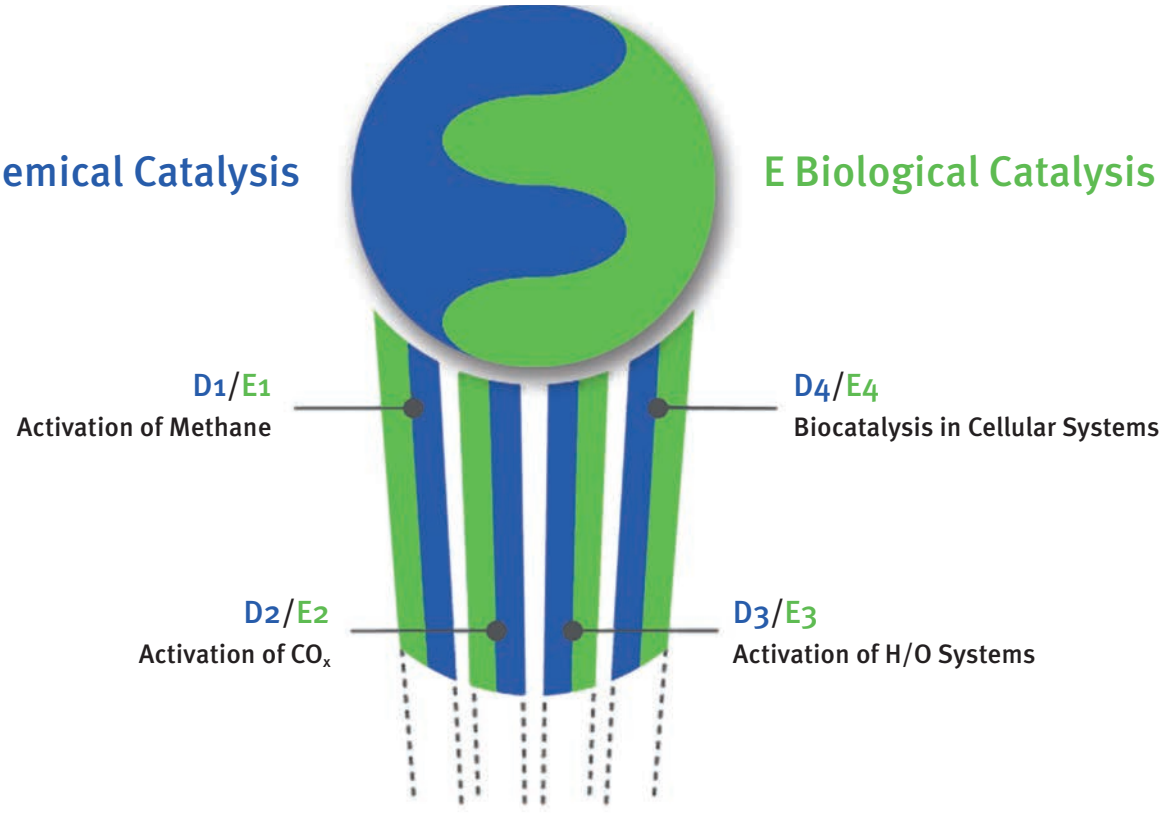
TU Berlin/press office/Ph. Arnoldt

Dr. Sandra Luber, University of Zurich, Switzerland

Organizational Structure

The Technische Universität Berlin is the host university of the Cluster of Excellence Unifying Concepts of Catalysis. The bodies that make up the cluster are the Chair, the Executive Board and the General Assembly of all members. The General Assembly elects the Chair and on his proposal the whole Executive Board.

The Scientific Advisory Board gives advice to the Executive Board in terms of scientific topics. Its members are high-ranking German and international scientists from academia and industry. The Chair represents and manages the Cluster. He is supported by the UniCat Office team.



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TU = Technische Universität Berlin; FU = Freie Universität Berlin; HU = Humboldt-Universität zu Berlin; UP = University of Potsdam; FHI = Fritz Haber Institute

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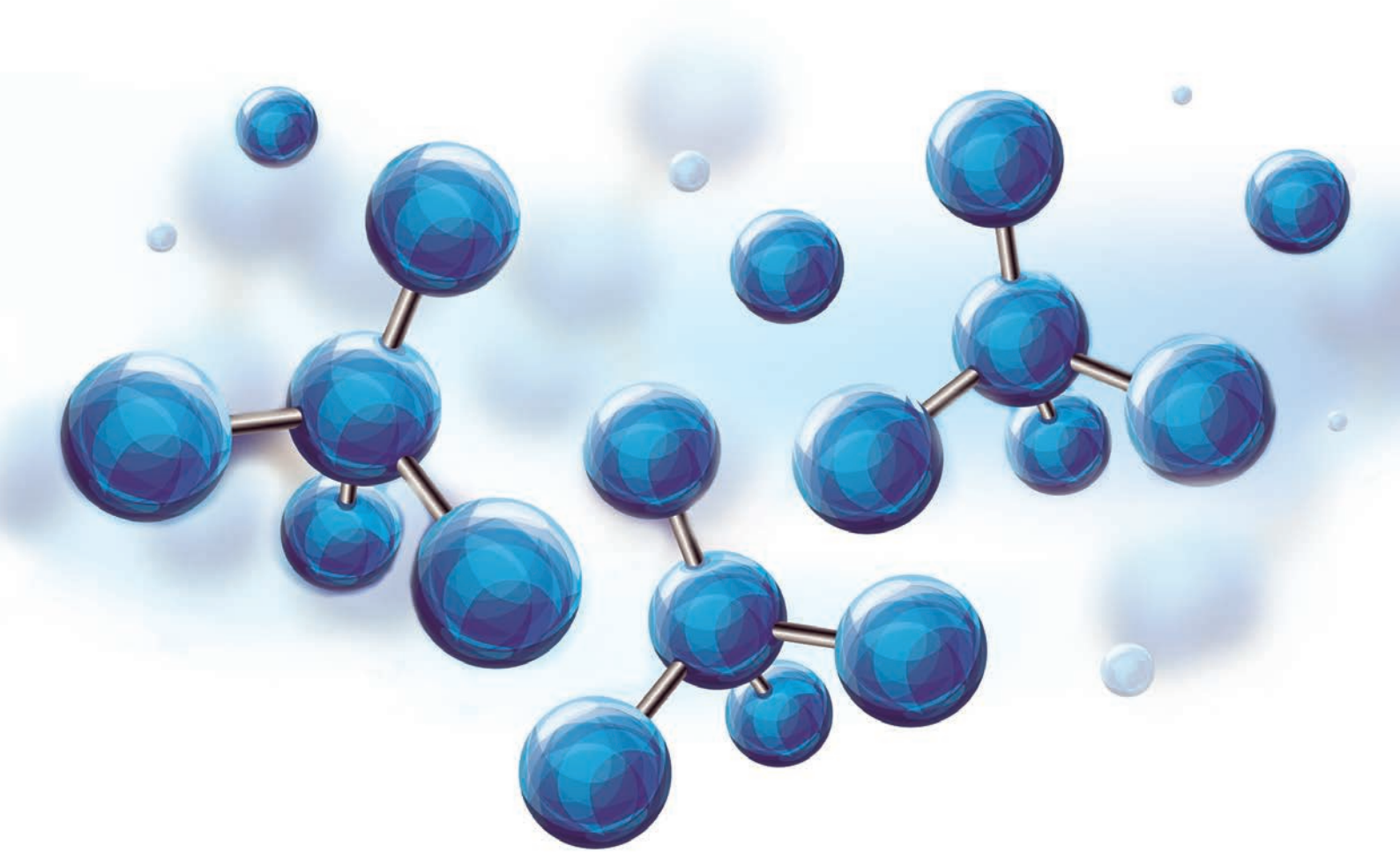

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