

Fundamental chemical research rooted in tradition and shaping the future

The Max-Planck-Institut für Kohlenforschung in Mülheim an der Ruhr is one of 84 institutes of the Max Planck Society and one of the internationally leading research institutions for chemical catalysis. With around 400 employees from over 38 nations, the institute comprises six research departments, numerous service departments with state-of-the-art analytics, and units for research infrastructure ranging from IT and administration to precision mechanical workshops. The research is broad and includes molecular as well as theoretical approaches with the goal of developing new chemical processes and reactions or making them more sustainable.



KARL ZIEGLER, 1963

In its more than 100-year history, numerous chemical discoveries of historical significance have been made at the institute. One of the first major successes was the development of the Fischer-Tropsch process by Franz Fischer and his coworkers in 1925. The use of catalysts enabled the conversion of coal into fuels such as gasoline or diesel.

Another milestone was the discovery of the Ziegler-Natta

process under institute director Karl Ziegler. This opened up new possibilities to polymerize ethylene and earned Ziegler the Nobel Prize in Chemistry in 1963. The "nickel effect" discovered by Günther Wilke or a process for decaffeinating green coffee beans were also developed in Mülheim. A highlight of more recent research history was the 2021 Nobel Prize in Chemistry awarded to director Benjamin List for the discovery of asymmetric organocatalysis.



BENJAMIN LIST, 2021

Working in Research



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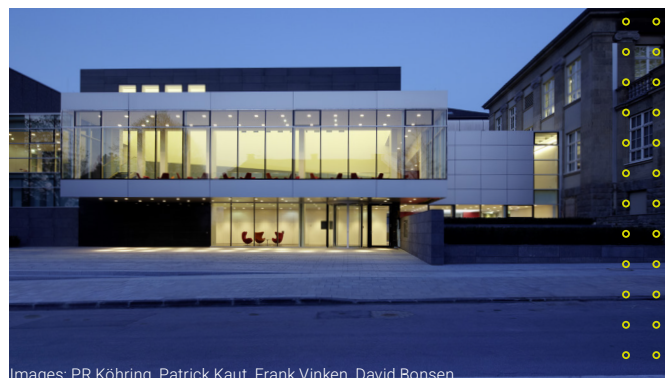
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WE DEVELOP NEW
CATALYSTS
FOR SUSTAINABLE
CHEMICAL PROCESSES

Organometallic Chemistry

Prof. Dr. Alois Fürstner

Carbon is able to bond with every metal in the periodic table of the elements. The aim of the department is the targeted use of the reactivity of the metal-carbon single, double, triple or π bonds to develop catalytic reactions. The main focus is the search for novel and broadly applicable chemical transformations. These methods are investigated mechanistically and tested in detail by synthesizing structurally complex and biologically active natural products.



Homogeneous Catalysis

Prof. Dr. Benjamin List

For a long time, chemists thought that there were only two types of well-functioning catalysts: on the one hand enzymes, which are used by all living beings, for example for the digestion of food, and on the other hand synthetic metal-containing compounds. A few years ago, the List research group discovered that metal-free compounds such as amino acids, which are non-toxic, can also catalyze many chemical reactions. This discovery has given chemists new tools, so-called "organic catalysts," with which they can produce, for example, plastics and pharmaceuticals in a more environmentally friendly and energy-efficient way.

Molecular Theory and Spectroscopy

Prof. Dr. Frank Neese

With modern computers, it is possible to calculate molecules and their properties with high accuracy and to realistically simulate chemical processes. To this end, one starts from the fundamental equations of quantum mechanics, which in principle describe chemistry exactly, and develops increasingly better approximation methods with the associated computer programs. These are then used to solve specific chemical problems in combination with experiments.



Organic Synthesis

Prof. Dr. Tobias Ritter

The research focuses on the development of new chemical reactions. The aim is to discover new molecular structures and reactivity that can contribute to solving scientific challenges. The laboratory works in the fields of synthetic organic chemistry, organometallic chemistry, and the synthesis of complex molecules. In addition, the scientists carry out mechanistic studies in order to gain easier access to molecules of interest for catalysis, medicine, and materials science.

Sustainable Catalysis

Dr. Josep Cornella

Transition-metal catalysis has become an indispensable tool in the development of efficient and synthetically feasible strategies for the activation of molecules. However, the use of rare, toxic, and expensive metal catalysts poses an enormous challenge that must be overcome, if true sustainability in these fields is to be achieved. For this purpose, the research group focuses on the invention and implementation of fundamental catalytic alternatives that ensure sustainable and environmentally friendly approaches in organic chemistry.



Heterogeneous Catalysis

Prof. Dr. Ferdi Schüth

The majority of the catalysts used in industry today are solids. Therefore, they are at the center of the department's activities. Using a variety of methods, the properties of the solids are manipulated on the nanometer scale in order to tailor the catalysts for the desired application. The goal is to develop better catalysts for chemical processes and reactions that are important for our energy supply. The group also employs unusual methods, such as supplying mechanical energy instead of conventional heating. Other interesting solid-state properties, such as optical and magnetic effects, are also investigated in these nanomaterials.