# History of the Max-Planck Institut für Kohlenforschung

The Max-Planck-Institut für Kohlenforschung (Coal Research) is one of the oldest of the Max Planck Society and was founded in 1914 as the "Kaiser-Wilhelm-Institut für Kohlenforschung". At the beginning of the 20$^{th}$ century little chemical research on coal was carried out, and German science and industry were increasingly interested in a more intensive analysis in order to make better use of this natural research which existed in abundance in the area around Mülheim an der Ruhr. This is also the reason why the founding of the Institute was a joint project of science (Kaiser-Wilhelm-Society), various companies in the coal and steel industry and the state.

The research goals of the institute, which were originally limited to ten years, were the direct conversion of coal energy into electricity, better coking processes, improvements in tar utilization and the extraction of liquid fuels from coal. The first director to be appointed was Franz Fischer, who previously held a chair at the TU Berlin. Immediately after the founding of the institute, the First World War broke out and it was forced to defer the current research goals because of more war-related tasks. After the end of the war Franz Fischer and his co-workers carried out basic research in a number of areas, concerning the formation and chemical composition of coal as well as on its conversion into solid, liquid and gaseous products.

The most important contribution culminated in the so-called Fischer-Tropsch process for coal liquefaction. In 1925 Franz Fischer and the head of research Hans Tropsch reported that liquid hydrocarbons (alkanes) can be produced from carbon monoxide and hydrogen in the presence of solid metal catalysts. The mixture of the two gases (synthesis gas) necessary for this new process was prepared by the "gasification" of coal with steam and oxygen at 900°C.

In the following years, the process was developed for large-scale application and successfully sold to the chemical industry, where it was mainly used for the production of synthetic fuels and paraffins. Today there is a renewed interest in Fischer-Tropsch technology with plants in Sasolburg/South Africa, Malaysia, and Qatar (using natural gas instead of coal).

Apart from that a company was founded in 1925 whose task it was to utilize the patents of the institute, in particular those of the Fischer-Tropsch process. This society still exists today: the Studiengesellschaft Kohle. Another important milestone in the history of the institute was set in 1939. Despite considerable resistance, Franz Fischer succeeded in transforming the institute into a

foundation and thus making it legally independent; a status from which the Max-Planck-Institut für Kohlenforschung still benefits today and which makes it, apart from another Institute, unique within the 86 institutes of the Max Planck Society.

After Franz Fischer retired in 1943 due to health reasons, Karl Ziegler (1898-1973) was appointed director of the Institute, who had previously worked at the University of Halle. When he took office, fundamental things changed at the Institute. After the founding of the Max Planck Society in 1948, which had emerged from the old Kaiser-Wilhelm-Society - and in the course of which the Institute was given its present name - the general orientation of the Institute changed. Ziegler moved away from application-oriented research for early industrial application to basic research, which he described as "general synthetic chemistry". Based upon earlier experiences Ziegler concentrated the work on organometallic chemistry, after researching organic compounds of alkali metals in Halle. In Mülheim he focused his attention on aluminium.

In 1949 Ziegler and his co-workers succeeded in developing the multiple addition of ethylene to aluminum alkyls which became known as the “build-up reaction”. The product of this oligomerization was a mixture of aluminum alkyls having long, linear alkyl chains attached to the metal; these compounds could be converted into £-olefins or primary alcohols, the latter being important for the production of biodegradable detergents. An unexpected observation during the systematic investigation of this reaction led to the discovery of the dramatic effect of transition metals on the “build-up reaction”; in particular, the addition of compounds of titanium or zirconium led to the coupling of up to 100 000 ethylene molecules at normal pressure and temperature. The optimized process utilized the so-called organometallic “mixed catalyst” consisting of an aluminum alkyl and a transition metal salt. The process was patented in 1953 and led to a stunning development of the industrial production of polyethylene and polypropylene as cheap and versatile polymers. The licensing of the patents enabled the Institute to be operated on an independent financial basis for nearly 40 years. As a result the Institute expanded and a number of new buildings such as the library, the main research laboratory, pilot plant facilities, high pressure workshops and an instrumental analysis building were constructed.

In 1963 Karl Ziegler was awarded the Nobel Prize for Chemistry for his groundbreaking discovery (together with Guilio Natta). In order to provide the Institute with financial scope for future action – independent from payments from the Max Planck Society – Ziegler established the Ziegler Fund in 1968 and the Ziegler Foundation in 1970, whose share capital came from license income from the polyethylene process. Both institutions still play an important role in financing the institute. In recognition of the fundamental importance of Karl Ziegler’s discoveries and their tremendous

implications for industry, the German Chemical Society (GDCh) bestowed the title “Landmark of Chemistry” on the Institute in 2008.

Günther Wilke (1925-2016) followed Karl Ziegler as director in 1969. Wilke received his doctorate from Karl Freudenberg in Heidelberg in 1951 and subsequently joined the Ziegler Group. He had been associated with the institute for almost 20 years before becoming its head. His researches as director concentrated on the organometallic chemistry of the transition metals (especially nickel) and their application in homogeneous catalysis. For example, the developed cyclodimerization and the cyclotrimerization of butadiene using homogeneous nickel catalysts were exploited industrially. Ligand-control led to the development of highly selective homogeneous catalysts, including catalysts bearing chiral enantiopure ligands.

The institute also pursued research in electrochemistry, contributing an efficient electrochemical synthesis of iron(II) ethanolate which became industrially important for the production of ferrocene. Investigations on the use of supercritical gases for purification purposes, which were first described by Kurt Zosel at the institute in 1963, led to a large-scale industrial process for the decaffeination of green coffee beans using supercritical carbon dioxide. Roland Köster, a scientific member of the Max Planck Society since 1969, led his own group during these years, which was primarily concerned with organoboron chemistry.

During Wilke's term of office, there were also many conversions and extensions to the institute site, such as the construction of the physics building, but also the spin-off of the Radiation Chemistry Department (1981), from which today's neighbouring Institute for Chemical Energy Conversion emerged.

In 1993 Manfred T. Reetz was appointed Director of the institute. He initiated projects concerning catalysis, transition metal colloids and directed evolution of enzymes. He also re-defined the scientific activities of the institute as a whole, a development which resulted in the establishment of five Departments comprising Synthetic Organic Chemistry, Homogeneous Catalysis, Heterogeneous Catalysis, Organometallic Chemistry and Theory. This plan foresaw the appointment of Scientific Members as Directors of these Departments. In 1995 Andreas Pfaltz joined the Institute as the Director of the Department of Homogeneous Catalysis, while Manfred T. Reetz headed the Department of Synthetic Organic Chemistry. Thereafter the appointments of Ferdi Schüth (Heterogeneous Catalysis), Alois Fürstner (Organometallic Chemistry) and Walter Thiel (Theory) followed. Thus, the scientific activities of the Institute were put on a broad and interdisciplinary basis.

Following Andreas Pfaltz' move back to Basel, the position of the Director of the Department of Homogeneous Catalysis remained vacant for some time. Benjamin List from the Scripps Research Institute, La Jolla, was identified as a pioneer in the then emerging field of organocatalysis. He was hired on a C3-position (associate professor) in 2003, and promoted to become the Director of the Department in 2005.

Manfred Reetz, although Emeritus since 2011, remains an external group leader of the institute; his laboratory is located at the Philipps-Universität Marburg, where he is Hans Meerwein Research Professor.

In 2015, Tobias Ritter was appointed as new director of the Department of Synthetic Organic Chemistry. His research interests are focused on the discovery of new reactivity that provides practical access to compounds of interest for catalysis, medicine and material science. The portfolio encompasses late-stage fluorination and its application to radiolabeling for positron emission tomography (PET); this particular line of research is made possible by a new radiochemistry laboratory.

In 2017, Walter Thiel became an Emeritus and in January 2018, Frank Neese was appointed as new Director of the Department of Molecular Theory and Spectroscopy. Frank Neese moved to the MPI from the neighboring Institute, the Max Planck Institute for Chemical Energy Conversion, where he was also director and leading an interdisciplinary group that combined spectroscopy and theory in development and application.

The directors of the departments form a board which is responsible for all decisions; the managing director is elected by this board. As successor to Manfred Reetz, Ferdi Schüth served as Managing Director from 2003-2005, followed by Walter Thiel (2006-2008), Alois Fürstner (2009-2011), Benjamin List (2012-2014), Walter Thiel (2015), Alois Fürstner (2016-2017), and Tobias Ritter (2018-2020).