Curriculum Vitae

Prof. Dr. Martin Muhler

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Academic education

1996	Habilitation in Industrial Chemistry at the Technische Universität Berlin
1989	PhD graduation in Physical Chemistry at the Freie Universität Berlin (summa cum laude)
1986	Diploma graduation in Chemistry at the Ludwig-Maximilians-Universität, Munich

Professional career

1996 – present	Full professor, Laboratory of Industrial Chemistry, Ruhr-University Bochum (RUB)
1991 – 1996	Head of the group "Heterogeneous catalysis" in the Physical Chemistry Department (head: Prof. G. Ertl) of the FHI Berlin
1989 – 1991	Postdoctoral fellow at Haldor Topsøe A/S in Denmark, Department of Fundamental Research in Heterogeneous Catalysis
1986 – 1989	PhD student in the Physical Chemistry Department (head: Prof. G. Ertl) of the Fritz Haber Institute (FHI) of the Max Planck Society (MPG) in Berlin

Professional activities

2014 – present	Chairman of the German Catalysis Society (GeCatS)
2013 – present	Member of the executive board of the German Catalysis Society (GeCatS)
2013 – present	Appointment representative of the rectorate of the RUB (Berufungsbeauftragter des Rektorates der RUB)
2013 – present	Member of the advisory board of the Institute of Catalysis Research and Technology (IKFT), Karlsruhe Institute of Technology (KIT)
2012 – present	Head of the local chapter of the German Chemical Society (GDCh) in Bochum
2011 – present	Member of the Topics Committee of the German Bunsen Society for Physical Chemistry (Themenkommission der DBG)
2009 – present	Member of the Academic Advisory Board of the Fonds der chemischen Industrie (VCI)

2009 – present	Member of the International Advisory Board of ChemCatChem (Heterogeneous, Homogeneous, and Biocatalysis)
2008 – present	Member of the International Advisory Board of ChemSusChem (Chemistry & Sustainability, Energy & Materials)
2009 – 2012	Spokesperson of the collaborative research center (SFB) 558 "Metal-substrate interactions in heterogeneous catalysis" funded by DFG
2009 - present	German representative in the European Federation of Catalysis Societies (EFCATS)
2008 – 2012	Member of the organizing committee of the 15th International Congress on Catalysis in Munich
2004 – 2007	Member of the International Advisory Board of Applied Catalysis A: General
2004 – 2012	Elected referee of the German Research Foundation (DFG) for Industrial Chemistry (Technische Chemie)
2004 – present	Member of the steering board of the International Max Planck Research School (IMPRS) for Surface and Interface Engineering in Advanced Materials (SurMat)
2003 – 2008	Chairman of the examination board of the Faculty of Chemistry and Biochemistry at the Ruhr University Bochum
2002 – present	President of the alumni association VFCh of the Faculty of Chemistry and Biochemistry
2000 – present	Head of the committee "Heterogeneous Catalysis", DECHEMA
2000 – present	German representative in the International Association of Catalysis Societies (IACS)
2000 – 2009	Vice spokesperson of the collaborative research center (SFB) 558 "Metal-substrate interactions in heterogeneous catalysis" funded by DFG
2000 – 2006	Executive director of the Center of Advanced Training of the Ruhr-University Bochum
2000 – 2002	Head of the Competence Network Catalysis (ConNeCat)
1999 – 2002	Vice dean of the Faculty of Chemistry at the Ruhr-University Bochum
1997 – 1999	Dean of the Faculty of Chemistry at the Ruhr-University Bochum

Awards, recognitions

2010	Price of the inventors competition. For a method of producing an electrocatalyst
2007	Second price in the fifth patent competition of the research ministry Northrhine-Westfalia 2007
1999	DECHEMA Prize of the Max Buchner Research Foundation
1996	Karl Winnacker fellowship
1986	"Chemiefonds" scholarship for PhD students
1983	Admission to the Studienstiftung des deutschen Volkes
1980	Scholarship of the Bavarian State Ministry of Sciences, Research and the Arts

Memberships in professional organizations

Gesellschaft deutscher Chemiker (GDCh), Deutsche Bunsengesellschaft für Physikalische Chemie (DBG), DECHEMA Gesellschaft für Chemische Technik und Biotechnologie, Deutsche Wissenschaftliche Gesellschaft für Erdöl, Erdgas und Kohle (DGMK), Verein zur Förderung der Chemie und Biochemie (VFCh)

Collaborators & other affiliations

R. Schlögl (Fritz Haber Institute of the Max Planck Society, Berlin)
W. Schuhmann (Ruhr-University Bochum)
F. Schüth (Max-Planck-Institut für Kohlenforschung; Mülheim)
R. Fischer (Ruhr-University Bochum)
Ch. Wöll (Karlsruhe Institute of Technology)
A. van Veen (University of Warwick)
K. de Jong (Utrecht, Netherlands)
X. Bao (Dalian Institute of Chemical Physics, China)
C. Liang (Dalian University of Technology, China)
B. M. Reddy (Indian Institute of Chemical Technology, Hyderabad, India)
Graduate Advisor: Gerhard Ertl, Postdoctoral Advisors: Hendrik Topsøe, Bjerne Clausen

Graduate Students supervised (past 5 years from total of 44)

P. Chen (RWTH Aachen), M. Holz (Ruhr-University Bochum/Fraunhofer UMSICHT), B. Mei (Technical University of Denmark), H. Schulte (Shimadzu Europa GmbH), H. Ruland (Ruhr-University Bochum), M. Becker (high throughput experimentation company), T. Franzke (BP), B. Graf (BASF SE), K. Kähler (Max Planck Institute for Chemical Energy Conversion) , N. Breuer (Lanxess), C. Jin (Bayer MaterialScience), H. Noei (DESY, Hamburg), A. Rittermeier (Bayer Material Science), S. Kundu (Department of Chemistry at Brookhaven National Laboratory), M. Rohe (Sachtleben Chemie GmbH), S. Kaluza (Fraunhofer UMSICHT)

Postdoctoral Scholars supervised (past 5 years from total of 24)

Z. Sun (ICCAS, Beijing, Chinese Academy of Sciences), M. Guraya (CA Bariloche, Argentina), Z. Liu (Dalian Institute of Chemical Physics, China), S. Miao (University of Iowa, USA) J. Qian (Bayer, Shanghai, China), M. Sanchez (CA Bariloche, Argentina), G. Shi (Nanjing University, China), A. van Veen (CNRS-IRCE Lyon, France), R. Chetty (University of Newcastle, UK).

Biographical Note

Prof. Dr. Martin Muhler is professor of Industrial Chemistry at the Ruhr-University of Bochum. He has coauthored over 340 publications (h-index = 47) and is co-inventor on 14 patents. He started studying chemistry in 1980 at the Ludwig-Maximilians-Universität in Munich and graduated as chemist (diploma) in 1986 supervised by Prof. G. Ertl. Afterwards he went to Berlin, where he worked on his PhD in Physical Chemistry at the Fritz Haber Institute (FHI) of the Max Planck Society. Again he was supervised by later Nobel prize winner Prof. G. Ertl. During his PhD studies he investigated the dehydrogenation of ethylbenzene over iron oxide-based catalysts. Martin Muhler graduated with summa cum laude in 1989. He spent the following two years as postdoctoral fellow at Haldor Topsøe A/S in Denmark. In the Department of Fundamental Research in Heterogeneous Catalysis he investigated the interaction of small molecules like carbon dioxide, carbon monoxide and hydrogen with copper-based catalysts for methanol synthesis. Subsequently he went back to Berlin, where he became the leader of the group "Heterogeneous catalysis" in the Physical Chemistry Department of the FHI Berlin from 1991 until 1996. During this time he investigated the interaction of oxygen with silver to clarify the relation between catalytic performance and microstructure of silver catalysts in oxidation reactions. Additionally, Martin Muhler performed fundamental research on the kinetics of the Ru- and Fe-catalyzed ammonia synthesis establishing a microkinetic model of ammonia synthesis over Ru. He completed his stay in Berlin with his Habilitation in Industrial Chemistry at the Technische Universität Berlin in 1996. Since 1996 Martin Muhler is full professor at the Laboratory of Industrial Chemistry at the Ruhr-University Bochum. Already in 1997 he became the dean of the Faculty of Chemistry until 1999. From 1999 till 2002 he was its vice dean, and from 2003 to 2008 he was the chairman of the examination board of the Faculty of Chemistry and Biochemistry at the Ruhr-University Bochum.

During his time in Bochum Prof. Muhler has been focusing on mechanisms and structure-reactivity relations of heterogeneously catalyzed redox reactions including hydrogenation as well as selective oxidation reactions over metal and metal oxide catalysts. He has extended experience in fundamental research including the development and synthesis of catalysts, elucidation of elementary steps at the atomic level, and identification of structural requirements for reactions occurring over redox catalysts applied in the gas or liquid phase. His experience in catalyst synthesis covers all basic methods and also advanced synthesis methods such as staged continuous co-precipitation, spray-drying, or chemical vapour deposition. In addition to characterization methods such as physisorption, chemisorption, thermal analysis, XRD, and TEM he developed a broad combination of advanced spectroscopic techniques reaching from vibrational to electron spectroscopy (XPS/ISS, MXPS/UPS) with kinetic measurements and their quantitative exploitation. The investigations focus on the interaction of the catalytically active surface with the reactants. The kinetic studies include transient methods, which are either performed in a temperature-programmed way (TPD, TPA, TPSR, TPR, and TPO), or isothermally (concentration steps and pulses, isotopes), as well as steady state kinetic measurements at atmospheric and elevated pressure. Additionally, Prof. Muhler has long-lasting experience in the temporal analysis of products in high vacuum using a TAP reactor and established adsorption calorimetry either in the static mode using a Tian-Calvet microcalorimeter or in the dynamical mode using a differential scanning calorimeter (DSC). The mechanistic studies at elevated and atmospheric pressure as well as in high vacuum require fast and quantitative mass spectrometry (MS), which is well established as an universal analysis method in his group. Numerous fully

automated flow set-ups with fixed-bed reactors in the laboratory scale equipped with online analysis including IR, MS, GC, etc. are operated continuously in the Laboratory of Industrial Chemistry.

In the field of catalyst synthesis Prof. Muhler focused on the growth, functionalization and application of carbon nanotubes in the last years. Recently, he entered heterogeneous photocatalysis based on semiconductor nanoparticles and electrocatalysis applying carbon-based redox catalysts.

Research highlights

At the beginning of his research in Bochum Prof. Muhler used his already achieved experience in ammonia synthesis and deepened the understanding of ammonia synthesis over ruthenium- and iron-based catalysts. Additionally, he contributed to getting insight into the catalytic properties of Pt supported on sulphated zirconia. Already at the very beginning of the 21st century Prof. Muhler also started extending his background by studying selective catalytic oxidations. At the same time the collaborative research center "Metal-substrate interactions in heterogeneous catalysis" funded by the DFG was started at the RUB with Prof. C. Wöll as spokesperson and Prof. Muhler being the vice spokesperson until 2009. Afterwards Prof. Muhler became the spokesman of SFB 558. Strong metal-support interactions were investigated, which are of great interest e.g. for methanol synthesis. Prof. Muhler's group focused at the $Cu/ZnO/Al_2O_3$-catalyzed methanol synthesis during the first periods of the SFB 558. The collaborative research center was extended three times to reach the maximal time period of 12 years until it was successfully closed in 2012. Within the SFB Prof. Muhler provided deep insight in the structure-reactivity relation of Cu-based methanol synthesis catalysts and developed knowledge-based advanced preparation methods for the catalyst synthesis. At later times in the SFB the focus was set to pure ZnO. A model of the reaction mechanism and the active site were established for the methanol synthesis over pure ZnO.

During the last periods of the SFB Au-catalyzed reactions synthesising methanol as well as consuming alcohols were additionally investigated. The role of the support oxide and the gold nanoparticles were clarified for both methanol oxidation and synthesis. Also within the scope of the collaborative research center 558 Prof. Muhler started to investigate liquid phase reactions. Methanol synthesis catalyzed by ZnO/Cu-colloids as well as alcohol oxidation in the liquid phase using Au-based catalysts were investigated. Additionally, an interesting class of inorganic/organic hybrid materials with zeolite-like structures and properties called metal organic frameworks (MOFs) were synthesized in cooperation with Prof. Fischer and their potential for catalytic applications was identified. Within the investigations of the interaction of small molecules with metal oxide and metal-based catalysts calorimetric measurements were developed in Prof. Muhler's group. Both static microcalorimetry and dynamic differential scanning calorimetry at atmospheric pressure are performed. A special pre-treatment reactor enables to pretreat catalysts at atmospheric pressure before transferring them into high vacuum. Fundamental studies were performed with ZnO-based catalysts for methanol synthesis as well as Fe-based catalysts for Fischer-Tropsch catalysts. The latter also became an important research topic in the last years completing Prof. Muhler's syngas expertise.

RuO_2 catalysts for oxidation reactions were also studied intensively by his group. It was possible to bridge the pressure and material gaps by investigations under both high vacuum and atmospheric pressure conditions with polycrystalline catalysts as well as single crystals. Another concern of Prof. Muhler is the development and characterization of ceria-based catalysts, which are of

great interest for environmental catalysis. The influence of dopants on the stability and activity of the materials form the main focus of the collaboration with the group of B. Reddy.

Prof. Muhler also has a large background in electrochemical research in cooperation with Prof. W. Schuhmann. The growth and especially the functionalysation of carbon nanotubes (CNTs) applied in electrocatalysis became a key aspect in his activities. Advanced synthesis of carbon nanotubes as well as of CNT-based catalysts are achieved. Due to the shortage of fossil fuels and the directly linked focus in chemical research on alternative energies and sources for chemical synthesis Prof. Muhler also pays attention to sustainable productions of chemicals. The dry reforming of methane using the greenhouse gases CO_2 and CH_4 for the production of synthesis gas is one example with heterogeneous photocatalysis being another. Recently Prof. Muhler built up an advanced photolaboratory investigating different catalytic active materials for overall water splitting and photochemical CO_2 reduction.

Most of Prof. Muhler's studies are assisted by advanced vibrational spectroscopy reaching from ATR, transmission FTIR, and DRIFTS measurements at atmospheric or elevated pressure to UHV techniques, which were established during Prof. Muhlers work at the RUB. HREELS studies are performed in cooperation with Prof. Wöll as well as IR-based measurements with single crystals and polycrystalline powder samples.