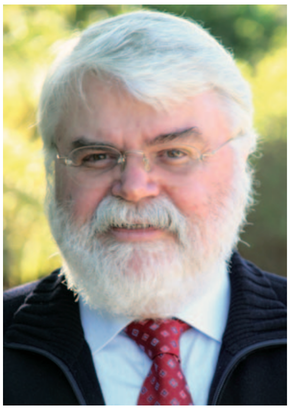
Author Profile



G. Erker

*The author presented on this page has recently published his **10th** paper since 2000 in Angewandte Chemie:*
"Frustrated Lewis Pairs: Metal-free Hydrogen Activation and More": D. W. Stephan, G. Erker, *Angew. Chem.* **2010**, *122*, 50–81; *Angew. Chem. Int. Ed.* **2010**, *49*, 46–76.

Gerhard Erker

Date of birth:	October 16, 1946
Position:	Professor at the Organisch-Chemisches Institut der Universität Münster, Münster (Germany)
Education:	1966–1970 Chemistry studies, Köln and Bochum (Germany) 1970 Diploma in Chemistry, Universität Bochum 1973 Dr. rer. nat. with Wolfgang Roth, Universität Bochum 1974–1975 Postdoc with Maitland Jones, Jr., Princeton University, New Jersey (USA)
Professional associations:	2000–2001 President of the German Chemical Society (GDCh), 2002–2008 Member of the Senate of the Deutsche Forschungsgemeinschaft (DFG); 2003–Present Member of the NRW Academy of Sciences and Arts
Awards:	**1986** Krupp Award, **1993** Max Planck Research Award, **1995** Otto Bayer Award, **2009** Adolf von Baeyer Medal (German Chemical Society)
Current research interests:	Metals can have a remarkable influence on organic molecules. My research group has for a long time been active in organometallic chemistry and catalysis. We have built up a strong experimental background in stoichiometric metallocene chemistry that has served as a reliable basis for designing and developing very active and selective homogeneous Ziegler–Natta olefin polymerization catalysts and for studying their remarkable modes of action. Recently my group has become involved in metal-free small-molecule activation by "frustrated Lewis pairs". Dihydrogen activation and metal-free catalytic hydrogenation are an issue, and we are currently involved in studying cooperative reactions of Lewis pairs with alkenes, alkynes, and even with carbon dioxide
Hobbies:	Music and art

When I was eighteen I wanted to be … either a chemist or a paleontologist.

My favorite piece of research is … the development of stereochemistry.

The biggest challenge facing scientists is … to solve the energy question.

If I could be anyone for a day, I would be … a (talented) artist.

If I could have dinner with three famous scientists from history, they would be … Alexander von Humboldt, Justus von Liebig, and Jacobus Henricus van't Hoff.

The most important future applications of my research is … the efficient catalytic activation of small molecules.

In my spare time I … love to listen to music.

If I were not a scientist, I would be … a teacher? A manager? I don't know, I am happy to be a scientist.

My favorite composer is … Gustav Mahler.

The secret of being a successful scientist is … good planning and good observation.

I would have liked to have discovered … the tetrahedral geometry of tetracoordinate carbon (as J. H. van't Hoff and J. A. Le Bel did).

A good work day begins with … time for the newspaper.

My favorite book is … "Die Vermessung der Welt" by Daniel Kehlmann.

My favorite opera is … Les Contes d'Hoffmann.

The most significant advance in chemistry of the last decade has been … the development of reliable computational chemistry methods.

How is chemistry research different now than it was at the beginning of your career?

Enormous progress in chemistry has come from significant advances in technical and analytical methodology and by a greatly increased interdisciplinarity of our profession. Today this allows us to tackle problems of general importance, but of a complexity in detail that was impossible to do decades ago. From the beginning of my career we have always collaborated with crystallographers and NMR specialists, but now we carry out bioorganometallic chemistry with the help of a biologist and study organic and organometallic surface chemistry jointly with colleagues from physics. To me the most significant and most amazing progress has been in theoretical chemistry/computational chemistry. Applications of advanced DFT programs such as those developed by my Münster colleague, Stefan Grimme, have opened new ways to gain a profound understanding of rather complex molecular systems and of unusual reaction modes.

Has your approach to chemistry research changed since the start of your career?

Collaboration between individual scientists, research groups, and institutions is more significant and important today then it was years ago. Chemical research has become a very international activity. I tremendously enjoy having a very international group and being in an institute and department with a pronounced international character. Many thanks to the Alexander von Humboldt foundation, the DAAD, the Deutsche Forschungsgemeinschaft, and others for helping us to carry out chemistry across borders. Working closely together with many top research groups around the world on timely projects is a great experience for everyone involved. It requires trust and friendship, which I am grateful to have received from so many collaborators from many countries.

Has your approach to publishing your results changed since the start of your career?

My way of publishing the results from my research group has not changed much over the years. I have always tried to be precise and detailed, so I have published many papers with a full experimental section. I have welcomed the introduction of the Supporting Information because it allows material and results to be presented more accurately. I see many benefits associated with the recent development that scientific journals will increasingly be only available electronically and not in print, especially its favorable economic component. Nonetheless, for me it is still a pleasure to browse an issue and to sit back and read an interesting scientific article from a well-made and attractively illustrated journal that I hold in my hands. I hope that this traditional way of publishing will not disappear altogether.

What do you think the future holds for your field of research?

Catalysis will always be of a prime importance in chemistry because it provides the most efficient ways of converting chemicals selectively to desired target products. Successful homogeneous catalysis requires a supporting stoichiometric molecular chemistry, whether it is organometallic or metal-free chemistry, which forms a reliable background for catalyst design and development. Many of the prime questions of our time, for example, in the energy sector, about protecting our environment, or about securing a reliable future chemical feedstock basis can only be tackled successfully with the aid of suitably developed catalyst systems.

Have you changed the main focus of your research throughout your career and if so why?

I was trained in physical organic chemistry as a doctoral student and that shines through much of my later work. I began my independent scientific career by doing stoichiometric organometallic chemistry mostly by using Group 4 bent metallocenes. This soon developed into studying model systems of catalytic processes and then into actual catalysis. Studying very active and selective catalytic processes has dominated my work for some time, although the group has at times turned to studying unprecedented types of organometallic compounds exhibiting very unusual bonding features. Our latest activity of metal-free small-molecule activation may appear to be in a different direction to this development, but it relies heavily on our previous experience with strongly electrophilic Lewis acidic materials.

What has been your biggest influence/motivation?

"Citius, altius, fortius" describes not only a driving force for olympic athletes, in some way it probably applies also to scientists. Both trying to advance the frontiers of our secured existing knowledge in the controlled manner of our scientific profession and mastering the challenge to make the seemingly impossible happen can be an enormous motivation. I remember the great feeling I had when my research group was able to combine a very air- and moisture-sensitive alkyl zirconocene cation with an ordinary oligopeptide and detected that it moved along the heavily functionalized backbone. Curiosity can be a very strong motivator.

What advice would you give to up-and-coming scientists?

I hesitate to give talented young scientists advice. If they are excellent they know what they want and what to do. I can only say that if I were in their

G. Erker has been featured on the cover of Angewandte Chemie:
"Reversible Metal-Free Carbon Dioxide Binding by Frustrated Lewis Pairs": C. M. Mömming, E. Otten, G. Kehr, R. Fröhlich, S. Grimme, D. W. Stephan, G. Erker, *Angew. Chem.* **2009**, *121*, 6770–6773; *Angew. Chem. Int. Ed.* **2009**, *48*, 6643–6646.

situation again today I would probably act similarly as I did many years ago, namely, I would try to select a topic of potential general interest and significance, if possible from a new emerging field, and work on projects that I personally find very fascinating.

What is the secret to publishing so many high-quality papers?

From the beginning of my career in chemistry I was fortunate to work at top institutions and labs with great colleagues and very good infrastructures. Excellent diplomands, doctoral students, and postdocs joined my laboratory and quickly liked the pleasant and scientifically challenging atmosphere in the group. In Münster my research group is part of a thriving institute and faculty with great colleagues and very talented and dedicated collaborators and staff. The young scientists in my group extensively use the many opportunities in this great scientific environment. It has been their excellent work that has led to the many publications contributed by the group over the years.

My 5 top papers:

1. "Experimental Characterization of the Alkene-Addition/-Insertion Energy Profile at Homogeneous Group 4 Metal Ziegler-Type Catalysts": M. Dahlmann, G. Erker, K. Bergander, *J. Am. Chem. Soc.* **2000**, *122*, 7986–7998.
   This is an important mechanistic paper in homogeneous Ziegler–Natta olefin polymerization chemistry and beyond. We used a unique combination of direct kinetic rate determination with dynamic NMR spectroscopy to characterize the energy profile of the first alkene-insertion sequence at a specially designed metallocene Ziegler–Natta catalyst. It turned out that, contrary to common belief, it is not alkene-addition but the olefin-insertion step that in this case controls the stereochemistry of polyolefin formation.
2. "Functional-Group Chemistry of Organolithium Compounds: Photochemical [2+2] Cycloaddition of Alkenyl-Substituted Lithium Cyclopentadienides": J. Paradies, G. Erker, R. Fröhlich, *Angew. Chem.* **2006**, *118*, 3150–3153; *Angew. Chem. Int. Ed.* **2006**, *45*, 3079–3082.
   Organolithium compounds are important synthetic reagents: they serve as potent nucleophiles and they are used as bases. We rarely think of organolithium compounds as systems that have a chemistry of their own at the lithiated carbanion stage itself. We had previously shown that bis(alkenyl-Cp) zirconium complexes (Cp = cyclopentadienyl) can rapidly undergo intramolecular photochemical [2+2] cycloaddition reactions under "dynamic topochemical reaction control" to yield the respective cyclobutylene-bridged *ansa* metallocenes. Here we expanded this method to (alkenyl-Cp) lithium chemistry by using the temperature-dependent equilibration of the simple Li(alkenyl-Cp)(solvent)$_n$ system with the Li(alkenyl-Cp)$_2$ lithiocene anion and Li(solvent)$_m$ cation salt derived from it. Substituted derivatives of these lithiocene anions undergo efficient intramolecular [2+2] cycloaddition when photolyzed at low temperature. The resulting ligand framework was used for transmetallation to yield new *ansa* metallocene systems.
3. "Metal-Free Catalytic Hydrogenation of Enamines, Imines, and Conjugated Phosphinoalkenylboranes": P. Spies, S. Schwendemann, S. Lange, G. Kehr, R. Fröhlich, G. Erker, *Angew. Chem.* **2008**, *120*, 7654–7657; *Angew. Chem. Int. Ed.* **2008**, *47*, 7543–7546.
   We have synthesized and characterized a series of intramolecular frustrated Lewis pairs. One of them, the (mesityl)$_2$P–CH$_2$–CH$_2$–B(C$_6$F$_5$)$_2$ system, stands out with regard to its high activity for heterolytic dihydrogen splitting. In addition, this unique system has the ability to rapidly transfer the H$^+$/H$^-$ pair to a variety of acceptor substrates including other less reactive Lewis pairs. It also rapidly transfers hydrogen to enamines. We developed this reaction into an efficient metal-free catalytic hydrogenation procedure. Work subsequently done after this initial publication extended this to catalytic hydrogenation reactions of silyl enolethers, conjugated dienamines, and related functional groups at sensitive organometallic frameworks employing this and related Lewis pair catalysts. This unique way of metal-free catalytic hydrogenation can apparently, in special cases, be an alternative to more conventional reduction methods of such substrates.
4. "Reversible Metal-Free Carbon Dioxide Binding by Frustrated Lewis Pairs": C. M. Mömming, E. Otten, G. Kehr, R. Fröhlich, S. Grimme, D. W. Stephan, G. Erker, Angew. Chem. 2009, 121, 6770–6773; *Angew. Chem. Int. Ed.,* **2009**, *48*, 6643–6646.
   We have recently reported an intramolecular ethylene-bridged bulky frustrated phosphine/borane Lewis pair that was very active in catalytic dihydrogen activation. The system reacts rapidly with carbon dioxide under mild conditions to yield the respective six-membered heterocyclic addition product. It cleanly releases the CO$_2$ molecule in solution above −20°C. We hope that this work will help to stimulate the development of advanced carbon dioxide chemistry in the future.
5. "Five-membered Zirconacycloallenoids: Synthesis and Characterization of Members of a Unique Class of Internally Metal-stabilized Bent Allenoid Compounds": J. Ugolotti, G. Kehr, R. Fröhlich, S. Grimme, G. Erker, *J. Am. Chem. Soc.* **2009**, *131*, 1996-2007.
   Treatment of a bulky zirconocene–bis(acetylide) with Piers' borane [HB(C$_6$F$_5$)$_2$] results in the formation of a unique five-membered metallacyclic cycloallenoid structure. The bent allenoid unit inside the five-membered ring is strongly stabilized by an internal electronic interaction with the mildly electrophilic zirconocene unit. This new compound complements a series of metal complexes, including U. Rosenthal's metallacyclocumulenes and N. Suzuki's metallacycloalkynes, which represent a class of compounds of their own. Formation pathways and bonding features of our new metallacycloallenoid complexes emphasise the unique role metal centres can play in generating and stabilizing very unusual bonding features at carbon centers.

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