Chem Soc Rev

This article was published as part of the

2008 Chemistry at Surfaces issue

Reviewing the latest developments in surface science

All authors contributed to this issue in honour of the 2007 Nobel Prize winner Professor Gerhard Ertl

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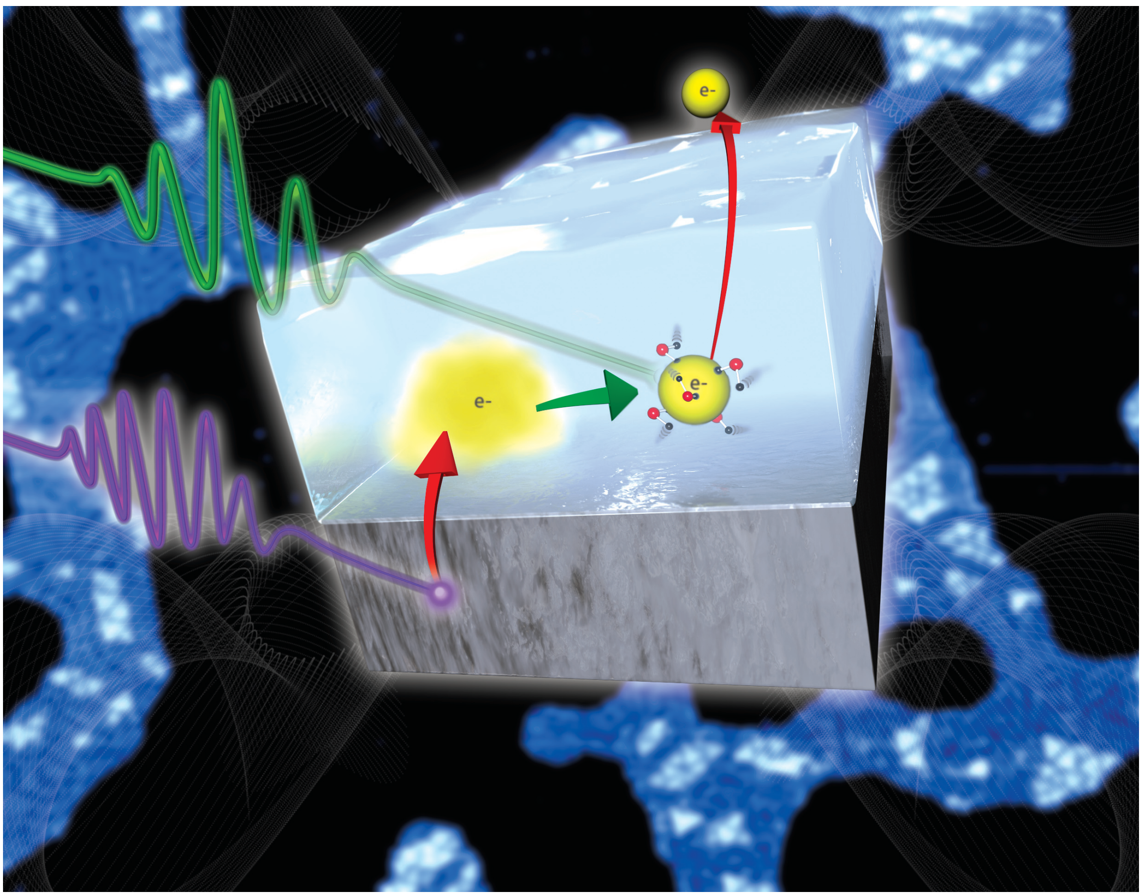

Chemistry at surfaces†

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DOI: 10.1039/b814437k

This special issue is dedicated to Prof. Dr Gerhard Ertl, who received the Nobel Prize in Chemistry 2007 "*for his studies of chemical processes on solid surfaces*". In its press release on October 10, 2007, The Royal Swedish Academy of Sciences specified: "*This year's chemistry laureate Gerhard Ertl has succeeded in providing a detailed description of how chemical reactions take place on surfaces and has in this way laid the foundation of modern surface chemistry*". Indeed, the pioneering work of Gerhard Ertl changed the approach to investigate solid surfaces and contributed to a deep understanding of processes relevant for applications in many fields, in particular in heterogeneous catalysis, corrosion, fuel cell research and the semiconductor industry, at the molecular level. Gerhard Ertl's research was always driven by the ambition to use the best available method to solve a problem at hand and, if necessary, to develop such methods. His outstanding scientific contributions range from "simple" systems, where the kinetics are dominated by a single rate-limiting step, as in the Haber–Bosch process, to "complex" systems, such oscillatory surface reactions, where non-linear dynamics prevail.

The scientific career of Gerhard Ertl started in the 1960s, when—driven by the emergence of semiconductor technology—new experimental methods became available. These methods allowed the investigation of molecular processes on well-defined single crystal surfaces under ultra-high vacuum conditions, *i.e.*, free of contaminations. Gerhard Ertl was one of the first to see the potential of these novel techniques. Along with other scientists, he contributed to the birth of the nowadays well-established scientific area of "Surface Science".

Looking back, we may ask, which were the key factors that drove the amazing development of this new scientific discipline, with thousands of active scientists today and numerous scientific journals dedicated to the field? From nowadays perspective, we realize that its interdisciplinarity is probably most important: At the boundaries of different disciplines new ideas are born. Certainly, surface science has become one of the classical examples of such interdisciplinary scientific creatures, fusing condensed matter physics, physical chemistry, and other "traditional" disciplines and, simultaneously, deriving outstanding motivation from the field of engineering, for example from heterogeneous catalysis. With novel insights obtained by novel methods, it became rapidly clear how little we knew about surface chemical reactions, in spite of their outstanding importance in many areas from chemical industry to everyday life. But more than this, a promising strategy became apparent that could help to unravel their long-standing secrets, such as the "black magic" mysteries of heterogeneous catalysis. And indeed, more than 70 years after the famous German patent entitled "*Verfahren zur synthetischen Darstellung von Ammoniak aus den Elementen*" ("A Process for the Synthesis of Ammonia from its Elements") was issued to Fritz Haber, Gerhard Ertl and his group published their groundbreaking work on the underlying reaction mechanisms.

Starting from these and many other pioneering contributions, step by step, the methodology of surface chemistry matured, and it was demonstrated how different experimental procedures can be used to provide a complete picture of a surface reaction. By a highly advanced spectrum of spectroscopic and microscopic equipment, it is nowadays possible to obtain insight into the behaviour of atoms and molecules on well-defined surfaces at the highest level of detail, and to understand their electronic, geometric, vibrational and chemical properties.

In this issue, examples of such state-of-the-art research topics are presented by a number of colleagues, who contributed to the emergence of Surface Science together with Gerhard Ertl and are still as active as he is, or by younger colleagues, who also significantly contributed to the present reputation of the field. The examples cover a wide field of subjects, from the preparation and detailed structural characterization of model catalysts, nanoscale phenomena in catalysis induced by faceting, investigations of surface reactivity ranging from nanoparticles to flat single crystal surfaces, the exploration of the nature and role of catalytically active sites, experimental and theoretical studies to unravel the mechanism of numerous surface reactions, the electronic and geometric structure of surface intermediates to the determination of reaction energetics and ultrafast electron transfer processes. In the course of these investigations, a large variety of experimental and theoretical methods have been applied, and, in many cases, only such multimethod approaches lead to a quality of results and physical and chemical insight, which meets the extremely high standards of Gerhard Ertl's work.

We would like to thank all the authors for overwhelming response and their great efforts to submit a rich variety of high-quality peer-reviewed contributions. We also wish to thank the editorial and production staff at the RSC for their superb assistance. Finally, we hope that this issue will provide a valuable reference and perspective for the entire research community working in Surface Science, who, as a whole, feels honoured by the Nobel Prize awarded to Prof. Gerhard Ertl. We are very grateful to him for being such an outstanding scientist and a great person.

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† Part of a thematic issue covering reactions at surfaces in honour of the 2007 Nobel Prize winner Professor Gerhard Ertl.

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Hans-Peter Steinrück (born 1959 in Austria) studied physics at the TU Graz (Diploma in 1983, PhD in 1985), was a postdoc at Stanford University (1985–1986) and received his Habilitation at the TU Munich in 1992. After a sabbatical at Rutgers University, he became Professor at the University of Würzburg in 1993; since 1998 he holds a chair of Physical Chemistry at the University of Erlangen-Nuremberg.

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Sir David King

Sir David King (born 1939 in South Africa) studied at the University of Witwatersrand (PhD 1964). After spells at Imperial College and the University of East Anglia, he held the Brunner Chair of Physical Chemistry at the University of Liverpool (1974–88) and the 1920 Chair of Physical Chemistry at the University of Cambridge (1988–2005). Elected a Fellow of The Royal Society in 1991, and Knighted in 2003, Sir David served as Chief Scientific Adviser to HM Government (2000–07) and is now Director of the Smith School for Enterprise and the Environment at Oxford University. He continues to conduct research in surface science within the Reactive Solid Surfaces group at Cambridge.

