The 26th Rudolf Brdička Memorial Lecture

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Controlled nanostructures for applications in catalysis and beyond

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J. Heyrovský Institute of Physical Chemistry,v.v.i.
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Controlled nanostructures for applications in catalysis and beyond

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Over the last decades, tremendous progress has been made in the control of catalytic materials on the nanometer size scale. This includes tailoring of pore sizes of catalytic materials by different soft and hard templating techniques, size control of catalytically active metal particles by solution phase synthesis of such particles and subsequent deposition on supports, the placement of catalytic particles in desired locations of structured support materials, and the design of solid environments which resemble ligand motifs of molecular catalysts.

A survey will be given on different methods to create defined pore systems in various materials. The placement of catalytically active particles in desired locations of such structured supports will be discussed for several examples. Encapsulation of single metal particles in hollow shells made of zirconia, titania or carbon allows the synthesis of catalysts which are stable against sintering, since individual particles are encapsulated and therefore cannot migrate towards each other, which prevents sintering. This pathway is highly flexible, if the parameters are fine-tuned, and a wide range of catalysts is accessible. Alternatively, if platinum particles are deposited in the mesopores of the shell, the platinum dispersion is thermally extremely stable, and the materials are highly interesting fuel cell catalysts. Ordered mesoporous materials also allow controlled placement of particles in the pores, and the resulting solids are suitable as high performance catalysts and in lithium ion batteries, for instance.

Finally, the synthesis of solids having ligand motifs of the Periana catalyst for the oxidation of methane to methylbisulfate (which can be hydrolyzed to methanol) has recently become possible. Such solids can be impregnated with suitable platinum species, upon which solid analogues to the Periana system result, with comparable catalytic activity for methane oxidation. This concept might be extendable to other catalytic systems so that a new range of solid catalysts could be synthesized.

Born on 8th July, 1960, in Warstein/Westfalia. Study of Chemistry and Law, University of Münster, doctorate University of Münster (1988), Postdoc Dpt. Chemical Engineering University of Minneapolis/USA (1988-1989), habilitation in inorganic chemistry University of Mainz (1995), Full Professor of Inorganic Chemistry University of Frankfurt/Main (1995-1998), Director and Scientific Member at the Max Planck Institute of Coal Research (since 1998), Honorary Professor University of Bochum (since 1999), Vice-President of the Max Planck Society (since 2014).

BRDIČKA LECTURES 1991-2015

1.	***(1991)***	*Edgar* ***HEILBRONNER*** *(Eidgenossische Technische Hochschule, Zürich)* "**The old Hűckel formalism**"
2.	***(1992)***	*Kamil* ***KLIER*** *(Lehigh University, Bethlehem, Pennsylvania)* "**Physical chemistry in two dimensions**"
3.	***(1993)***	*Joshua* ***JORTNER*** *(Tel Aviv University, Tel Aviv)* "**Clusters – a bridge between molecular and condensed matter chemical physics"**
4.	***(1994)***	*David J.* ***SCHIFFRIN*** *(The University of Liverpool)* "**Electrochemistry in two-dimensional systems**"
5.	***(1995)***	*Josef* ***MICHL*** *(University of Colorado, Boulder, Colorado)* "**Molecular kit for new materials**"
6.	***(1996)***	*Gerhard* ***ERTL*** *(Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin)* "**Self-organization in surface reactions**"
7.	***(1997)***	*Roger* ***PARSONS*** *(University of Southampton)* "**Electrochemistry in the last 50 years: from Tafel plotting to scanning tunnelling**"
8.	***(1998)***	*G. Barney* ***ELLISON*** *(JILA and University of Colorado, Boulder, Colorado)* "**The chemical physics of organic reactive intermediates in combustion and atmospheric processes**"
9.	***(1999)***	*Henry F.* ***SCHAEFER III*** *(University of Georgia, Athens, Georgia)* "**The third age of quantum chemistry**"
10.	***(2000)***	*Alexis T.* ***BELL*** *(University of California and Lawrence Berkeley Laboratory, Berkeley, California)* "**Progress towards the molecular design of catalysts –lessons learned from experiments and theory**"
11.	***(2001)***	*Mario J.* ***MOLINA*** *(Massachusetts Institute of Technology, Cambridge, Massachusetts)* "**The Antarctic ozone hole**"
12.	***(2002)***	*Jean-Marie* ***LEHN*** *(Université Louis Pasteur, Strasbourg a Collége de France, Paris)* "**Selforganization of supramolecular nanodevices**"
13.	***(2003)***	*Helmut* ***SCHWARZ*** *(Technische Universität Berlin)* "**Elementary processes in catalysis: looking at and learning from** "**naked**" **transition ion**"
14.	***(2004)***	*Rudolph A.* ***MARCUS*** *(California Institute of Technology, Pasadena)* **"Strange isotope effects in stratospheric ozone and in the earliest minerals in the solar system"**
15.	***(2005)***	*Avelino* ***CORMA*** *(Instituto de Tecnología Química, Valencia)* **" Supramolecular Entities Based on Molecular Sieves for Catalysis and Synthesis of New Materials**"
16.	***(2006)***	*Paul* ***CRUTZEN*** *(Max Planck Institute for Chemistry, Mainz):* **"Atmospheric Chemistry and Climate in the ´Anthropocene´"**
17.	***(2007)***	*Harry B.* ***GRAY*** *(California Institute of Technology, Pasadena)* **"The Currents of Life: Electron Flow through Metalloproteins"**
18.	***(2008)***	*Michael* ***GRÄTZEL*** *(Ecole Polytechnique Fédérale de Lausanne)* "**Mesoscopic Electrodes for Generation and Storage of Electric Power from Sunlight"**
19.	***(2009)***	*Gabor. A.* ***SAMORJAI*** *(Department of Chemistry and Lawrence Berkeley Natkional laboratory, University of California, Berkeley)* **"Molecular Foundations of Heterogeneous Catalysis"**
20.	***(2010)***	*Pavel* ***HOBZA*** *(Institute of Organic Chemistry and Biochemistry of the AS CR)* **"Noncovalent Interactions and their Role in Chemistry and Biochemistry"**
21.	***(2011)***	Klaus ***MÜLLEN*** *(Max-Planck Institute, Mainz, Germany)* **"Carbon Materials and Graphenes"**
22.	***(2012)***	*Enrico* ***GRATTON*** *(University of California, Irvine)* **"Nanoimaging technique with high time and spatial resolution: Mechanisms of translocation through the nuclear pore complex"**
23.	***(2013)***	*J. Peter* ***TOENNIES*** *(Göttingen, Germany)* **"Superfluid Helium Nanodroplets: Very Cold and Extremely Gentle"**
24.	***(2014)***	*Christian* ***AMATORE*** *(CNRS Paris, France)* **" Seeing, Monitoring, Measuring and Understanding Vesicular Exocytosis of Neurotransmitters with Ultramicroelectrodes"**
25.	***(2015)***	*Ulrike* ***DIEBOLD*** *(TU Wien, Austria)* **"Surface Science of Metal Oxides"**

Rudolf BRDIČKA
(1906-1970)

Professor of physical chemistry at Charles University, founding member of the Czechoslovak Academy of Sciences, founder and first director of the Institute of Physical Chemistry of the Czechoslovak Academy of Sciences.

An outstanding electrochemist renowned in particular by his pioneering work on kinetic polarographic current and on applications of polarography in medicine. A brilliant university teacher, author of an internationally recognized textbook of physical chemistry. He has crucial merits for development of modern physical chemistry in this country.

To commemorate his work and personality, the Institute of Physical Chemistry of the Academy of Sciences of the Czech Republic has organized since 1991 annually a festive R. Brdička Lecture. Invited speakers have been eminent scientists active in some field relating to the research currently pursued in the Institute.