



The 21st Rudolf Brdička Memorial Lecture

Professor Klaus Müllen

*Max-Planck-Institute for Polymer Research,
Mainz, Germany*

Carbon Materials and Graphenes

June 14, 2011 at 14:00 am

**J. Heyrovsky Institute of Physical Chemistry, v.v.i.
Academy of Sciences of the Czech Republic
Prague 8, Dolejškova 3.**

Carbon Materials and Graphenes

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Research into energy technologies and electronic devices is strongly governed by the available materials. We introduce a synthetic route to graphenes which is based upon the cyclodehydrogenation (“graphitization”) of well-defined dendritic (3D) polyphenylene precursors. This approach is superior to physical methods of graphene formation such as chemical vapour deposition or exfoliation in terms of its (i) size and shape control, (ii) structural perfection, and (iii) processability (solution, melt, and even gas phase). The most convincing case is the synthesis of graphene nanoribbons under surface immobilization and in-situ control by scanning tunnelling microscopy.

Columnar superstructures assembled from these nanographene discs serve as charge transport channels in electronic devices. Field-effect transistors (FETs), solar cells, and sensors are described as examples.

Upon pyrolysis in confining geometries or “carbomesophases”, the above carbon-rich 2D- and 3D- macromolecules transform into unprecedented carbon materials and their carbon-metal nanocomposites. Exciting applications are shown for energy technologies such as battery cells and fuel cells. In the latter case, nitrogen-containing graphenes serve as catalysts for oxygen reduction whose efficiency is superior to that of platinum.

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Prof. Dr. Klaus Müllen joined the Max-Planck-Society in 1989 as one of the directors of the Max-Planck Institute for Polymer Research. He obtained a Diplom-Chemiker degree at the University of Cologne in 1969 after work with Professor E. Vogel. His Ph.D. degree was granted by the University of Basel, Switzerland, in 1972 where he undertook research with Professor F. Gerson on twisted pi-systems and EPR spectroscopic properties of the corresponding radical anions. In 1972 he joined the group of Professor J.F.M. Oth at the Swiss Federal Institute of Technology in Zürich where he worked in the field of dynamic NMR spectroscopy and electrochemistry. He received his habilitation from the ETH Zürich in 1977 and was appointed Privatdozent. In 1979 he became a Professor in the Department of Organic Chemistry, University of Cologne, and accepted an offer of a chair in Organic Chemistry at the University of Mainz in 1983. He received a call to the University of Göttingen in 1988.

BRDIČKA LECTURES

1. (1991) Edgar **HEILBRONNER** (*Eidgenössische Technische Hochschule, Zürich*)
"The old Hückel 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 Collège 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 National laboratory, University of California, Berkeley*)
"Molecular Foundations of Heterogeneous Catalysis"
20. (2010) Pavel **HOBZA** (*Institute of Organic Chemistry and Biochemistry of the ASCR, v. v. i., Prague*)
"Noncovalent Interactions and their Role in Chemistry and Biochemistry"



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.