



# MOLECULAR FRONTIERS SYMPOSIUM 2008

January 10-11, 2008, Biopolis, Singapore

GENERATING SYNERGIES WITH MOLECULAR SCIENCE



MOLECULAR  FRONTIERS

[www.molecularfrontiers.org](http://www.molecularfrontiers.org)  
[www.moleclues.org](http://www.moleclues.org)



Institute of  
Bioengineering and  
Nanotechnology  
A\*STAR

[www.ibn.a-star.edu.sg](http://www.ibn.a-star.edu.sg)



[yrp.ibn.a-star.edu.sg](http://yrp.ibn.a-star.edu.sg)



5<sup>th</sup> IBN  
Anniversary 2003 - 2008  
5 Years of Innovative Research

## MESSAGE FROM SYMPOSIUM CHAIR

**T**he Institute of Bioengineering and Nanotechnology (IBN) and its Youth Research Program (YRP) are delighted to host the 2<sup>nd</sup> Molecular Frontiers Symposium in Biopolis, together with the Molecular Frontiers Foundation.

Held for the first time outside of Sweden, the Symposium will feature eminent scientists from around the world, including four Nobel and Royal Swedish Academy of Sciences laureates, as well as six other award-winning researchers from diverse scientific fields.

Our invited panel of expert speakers would deliver an exciting program focused on the latest research advances in molecular sciences and their impact on society. The topics that would be covered include molecular recognition and function, molecular catalysis, synthetic polymers, pharmaceuticals synthesis; mini-DNA synthesis, self-assembling peptide systems, quantum dots and nanoparticles; carbon nanotubes, and nanocomposite biomaterials.

In conjunction with the Symposium, we are also pleased to host the 1<sup>st</sup> Molecular Frontiers Forum, specifically targeted at students and their educators. At the Forum, the scientists will share their research experiences, their scientific career path towards winning the Nobel Prize, and their vision for the future through interactive panel discussions. Through this exposure, we hope to share with our youth the tremendous impact of research on society, and encourage them to pursue the exciting and rewarding journey of scientific discoveries.

We would like to thank our sponsors and our partners, the Nanyang Technological University (NTU), the National University of Singapore (NUS), and the NUS Department of Chemistry for their support, which has enabled more than 340 students from 19 schools to participate in Molecular Frontiers 2008.

We are pleased to welcome you to the Molecular Frontiers Symposium and Forum in Singapore, and hope that you would enjoy the program.



**Prof. Jackie Y. Ying**

Chair, Molecular Frontiers Symposium and Forum 2008  
Executive Director, Institute of Bioengineering and Nanotechnology (IBN), Singapore  
Advisor, Youth Research Program, IBN

## MESSAGE FROM FOUNDATION CHAIR



**T**he Molecular Frontiers Foundation was set up to promote awareness for chemistry and the molecular sciences to the international community, in particular the young, and this Symposium is the first international symposium we are organizing outside of Sweden in line with this aim.

Molecular Frontiers is a worldwide virtual institute that promotes science and the understanding of molecular science in society through a global effort. Our science-based intellectual platform provides global open access to scientific knowledge for education and international exchange. Molecular Frontiers is therefore a forum for exchange and analysis of scientific advances and their implications.

Our Scientific Advisory Board meets regularly to identify and analyze key scientific developments and is comprised of prominent international researchers representing a wide range of molecular science disciplines. Our global think tank studies emerging technologies, future advancements and areas for further development in a wide range of scientific disciplines.

Besides reaching out to the scientific research community through the 2<sup>nd</sup> Molecular Frontiers Symposium at Biopolis, Singapore, Molecular Frontiers is making strong efforts to engage the young generation in scientific pursuit through the 1<sup>st</sup> Molecular Frontiers Forum. With our focus on youth, we aim to inspire scientific curiosity in young people about how the world we live in is influenced by molecular sciences.

By inviting key Academy laureates and other leading experts to Singapore to address more than 500 researchers and students, we look forward to conveying our message to a wider audience.

**Prof. Bengt Nordén**

Chair, Molecular Frontiers Foundation  
Royal Swedish Academy of Sciences  
Chalmers University of Technology, Sweden

## THURSDAY, 10 JANUARY 2008

9.30am to 9.35am	<b>Welcome Address by Chair, 2<sup>nd</sup> Molecular Frontiers Symposium</b> Professor Jackie Y. Ying, Executive Director, Institute of Bioengineering and Nanotechnology, Singapore
9.35am to 9.40am	<b>Address by Chair, Molecular Frontiers Foundation</b> Professor Bengt Nordén, Chalmers University of Technology, Sweden
9.40am to 10.40am	<b>Plenary Lecture: Click Chemistry: Modular Synthesis for Function</b> Professor K. Barry Sharpless, Nobel Prize in Chemistry (2001) The Scripps Research Institute and The Skaggs Institute for Chemical Biology, USA
10.40am to 11.10am	<b>Tea Reception</b>
11.10am to 11.55pm	<b>Keynote Lecture: Self-Assembling Peptide Systems</b> Professor Shuguang Zhang, Massachusetts Institute of Technology, USA
11.55am to 12.55pm	<b>Lunch</b>
12.55pm to 1.55pm	<b>Plenary Lecture: Catalytic Reduction of Dinitrogen to Ammonia Under Mild Conditions with Protons and Electrons</b> Professor Richard Schrock, Nobel Prize in Chemistry (2005) Massachusetts Institute of Technology, USA
1.55pm to 2.40pm	<b>Keynote Lecture: Excited Electronic States of Ag Nanocrystals</b> Professor Louis Brus, Columbia University, USA
2.40pm to 3.25pm	<b>Keynote Lecture: Nanocomposite Engineering of Biomaterials</b> Professor Jackie Y. Ying, Executive Director, Institute of Bioengineering and Nanotechnology, Singapore
3.25pm to 3.55pm	<b>Coffee/Tea</b>
3.55pm to 4.55pm	<b>Plenary Lecture: Discovery of Carbon Nanotubes</b> Professor Sumio Iijima, The Royal Swedish Academy of Sciences Gregori Aminoff Prize (2007) NEC Corporation, Meijo University and Research Center for Advanced Carbon Materials, Japan
4.55pm to 5.40pm	<b>Keynote Lecture: Dynamic Aspects of Molecular Recognition, Assembly and Function</b> Professor Bengt Nordén, Chalmers University of Technology, Sweden
5.40pm	<b>End of Day One</b>

## FRIDAY, 11 JANUARY 2008

9.30am to 10.30am	<b>Plenary Lecture: Asymmetric Catalysts: Structural and Functional Engineering</b> Professor Ryoji Noyori, Nobel Prize in Chemistry (2001) RIKEN and Nagoya University, Japan
10.30am to 11.00am	<b>Coffee/Tea</b>
11.00am to 11.45am	<b>Keynote Lecture: Mini-DNA with Interesting Properties Synthesized by Click Chemistry</b> Professor Tom Brown, University of Southampton, UK
11.45am to 12.45pm	<b>Lunch/End of Day Two</b>

**K. Barry Sharpless**

*Nobel Prize in Chemistry (2001)*  
*The Scripps Research Institute and*  
*The Skaggs Institute for Chemical Biology, USA*



Prof. K. Barry Sharpless is the W. M. Keck Professor of Chemistry, The Scripps Research Institute, La Jolla, California. Though an academic, Sharpless has always looked for “useful” new chemical methods. He regards the oxidation of olefins as the single most versatile, powerful and reliable class of transformations in organic synthesis, so improving existing oxidative reactions and discovering new ones is a priority. He is best known for discovering general reactions for catalytic asymmetric epoxidation, dihydroxylation, and aminohydroxylation, for which he received the Nobel Prize in 2001. Current research focuses on click chemistry, his new synthetic stratagem for the rapid discovery of chemical function. A copper-catalyzed ‘fusion’ of azides and alkynes developed at Scripps is a near-universal best reaction for click chemistry, functioning under essentially all conditions (even in living cells) and proving to be a route to highly diverse chemical products of all types, whether polyolefins, smart materials or drugs. Sharpless graduated from Dartmouth College, received a Ph.D. from E. E. van Tamelen, Stanford University, and postdoced with J. P. Collman, Stanford, and at Harvard with Konrad Bloch. He served on the faculties of MIT (1970-1977), Stanford (1977-1980), MIT (1980-1990), and The Scripps Research Institute and its Skaggs Institute for Chemical Biology (1990-present).

**Richard Schrock**

*Nobel Prize in Chemistry (2005)*  
*Massachusetts Institute of Technology, USA*



Prof. Richard Schrock is the Frederick G. Keyes Professor of Chemistry, Massachusetts Institute of Technology, USA. His research has been focused on the fields of synthetic and mechanistic organotransition metal and inorganic chemistry, catalysis, and polymers. Prof. Schrock shared the Nobel Prize in Chemistry with Y. Chauvin and R. H. Grubbs in 2005 for their work on the development of the metathesis method in organic synthesis. Among his other awards are the ACS Award in Organometallic Chemistry (1985); the Harrison Howe Award of the Rochester ACS section (1990); an Alexander von Humboldt Award (1995); the ACS Award in Inorganic Chemistry (1996); the Bailar Medal from the University of Illinois (1998); and an ACS Cope Scholar Award in 2001. He was the Sir Geoffrey Wilkinson Lecturer and Medalist (2002) and the Sir Edward Frankland Prize Lecturer (2004), and has received the F. Albert Cotton Award in Synthetic Inorganic Chemistry (2006); the Theodore Richards Medal from the Northeast ACS section (2006), and the August Wilhelm von Hofmann Medal from the German Chemical Society (2005). He has also been elected to the American Academy of Arts and Sciences and the National Academy of Sciences. He was Associate Editor of *Organometallics* for eight years, and has published approximately 450 research papers.

## Ryoji Noyori

*Nobel Prize in Chemistry (2001)*  
*RIKEN and Nagoya University, Japan*



Prof. Ryoji Noyori is University Professor of Nagoya University and President of RIKEN, Japan. He is known for his research interest in the fundamentals and applications of molecular catalysis based on organometallic chemistry. Prof. Noyori won the Nobel Prize in Chemistry in 2001 together with W. S. Knowles and K. B. Sharpless for their work on chirally catalysed reactions. He has also received the Asahi Prize (1992); the Tetrahedron Prize (1992); the Japan Academy Prize (1995); the Arthur C. Cope Award (1997); the King Faisal International Award (1999); the Order of Culture (2000); the Wolf Prize (2001) and the Roger Adams Award (2001). He is a member of the Japan Academy and the Pontifical Academy of Sciences, and is a foreign member of the National Academy of Sciences, USA, the Russian Academy of Sciences, and the Royal Society, UK.

## Sumio Iijima

*Gregori Aminoff Prize (2007)*  
*NEC Corporation, Meijo University and*  
*Research Center for Advanced Carbon*  
*Materials, Japan*



Prof Sumio Iijima has been Professor at Meijo University, Nagoya since 1999 and he has been appointed as Director of Research Center for Advanced Carbon Materials at AIST in Japan and also partly works as a Special Research Fellow at NEC. After graduating from Tohoku University, he moved to Arizona State University where he developed high-resolution transmission electron microscopy (HRTEM) (1970-1982), which is the basis of the current TEM method. In 1982 he returned to Japan and worked for 5 years for the Japanese government research project (ERATO) on nanoparticles, and joined the NEC fundamental research laboratories in 1987. In 1991 he discovered carbon nanotubes that have initiated nano-materials science and nanotechnology. The discovery honored him with numerous awards, prizes and Honorary Doctorates including the 2001 Franklin Medal in Physics, the Agilent Europhysics award and the APS McGroddy Prize, the Imperial Prize and the Japan Academy Prize and Person of Cultural Merits (2002). In 2007, he was awarded the Gregori Aminoff Prize (Sweden), the Balzan Prize (Italy), and was also elected as the foreign associate of the National Academy of Science (USA).

**Bengt Nordén**

*Chalmers University of Technology and  
Royal Swedish Academy of Sciences, Sweden*



Prof. Bengt Nordén is Professor of Physical Chemistry at Chalmers University of Technology, Sweden. His research interests are mechanisms of molecular recognition and function; DNA-supramolecular structures involving small as well as large molecules: chiral substitution-inert metal complexes and peptide nucleic acids. Prof. Nordén is known for having developed spectroscopy with polarized light (linear dichroism) addressing biomolecular structures, e.g. 3D structure of DNA-recombinase complex in solution and cell-penetrating peptides, as well as membrane translocation mechanisms. He has been awarded the Göran Gustafsson Prize in 1992. Since 1991, Prof. Nordén has been an elected member of the Royal Swedish Academy of Sciences. He has been the Chairman of the Nobel Committee for Chemistry of the Royal Swedish Academy of Sciences during 2001-2004 and has been a member of this committee from 1996. He is President of the Chemistry Class of the Royal Swedish Academy since 2004. He is also Chairman of the Board of Directors of the Molecular Frontiers Foundation, a global think tank that promotes molecular sciences.

**Erik Thulstrup**

*Roskilde University, Denmark*



Prof. Erik Thulstrup is Professor at the Department of Science, Systems and Models, Roskilde University, Denmark. His research focuses on polarization spectroscopy, where he developed a method for the production of aligned molecular samples and for optical spectroscopic studies of such samples. He is the author of three leading monographs in the field. Prof. Thulstrup also has interests in the role of scientific research and science education for economic development. He has done extensive science policy and research evaluation work in Eastern Europe, Africa, Asia, and Latin America for several donors and development banks. He was elected in 1996 to be the first and only Danish Fellow of the Third World Academy of Sciences. He has been a Fellow of the Norwegian Academy of Sciences since 1999.

**Jackie Y. Ying**

*Institute of Bioengineering and Nanotechnology,  
Singapore*

Prof. Jackie Y. Ying is Executive Director of the Institute of Bioengineering and Nanotechnology, Singapore, since 2003. Prof. Ying has been on MIT's Chemical Engineering faculty since 1992, and was promoted to Professor in 2001. She has been recognized with a number of research awards, including the American Ceramic Society Ross C. Purdy Award, David and Lucile Packard Fellowship, Office of Naval Research Young Investigator Award, National Science Foundation Young Investigator Award, Camille Dreyfus Teacher-Scholar Award, Royal Academy of Engineering ICI Faculty Fellowship, American Chemical Society Faculty Fellowship Award in Solid-State Chemistry, Technology Review TR100 Young Innovator Award, American Institute of Chemical Engineers (AIChE) Allan P. Colburn Award, and Chemical Engineering Science Peter V. Danckwerts Lectureship. She was named in the centennial issue of MIT's Technology Review magazine as one of the world's 100 young people likely to lead 21st Century innovators. In 2005, she was appointed to be among 237 leaders in the World Economic Forum's panel of Young Global Leaders, and was also elected as a member of the German Academy of Natural Scientists, Leopoldina. Prof. Ying serves on the Advisory Board of the Society for Biological Engineering and the Molecular Frontiers Foundation. In 2006, she was appointed by the U.S. National Academy of Engineering to serve on the blue-ribbon committee that identifies the grand challenges and opportunities for engineering.

**Louis Brus***Columbia University, USA*

Prof. Louis Brus is the Samuel Latham Mitchill Professor of Chemistry and Professor of Chemical Engineering and Applied Chemistry at Columbia University, USA. Prof. Brus has been honored as NSF Predoctoral Fellow from 1966-1969. He was Elected Fellow of the American Physical Society in 1980 and Elected Fellow of the American Academy of Arts and Sciences in 1998. In 2004, he was elected to the U. S. National Academy of Sciences in Chemistry. Prof. Brus received the Herman Bloch Award "For Scientific Excellence in Industry" from the University of Chicago in 1995. He was Chairman of the Gordon Conferences Board of Trustees in 1998. In 2001, he received the Irving Langmuir Prize in Chemical Physics from the American Physical Society. He also received the Chemistry of Materials Prize from the American Chemical Society (2005) and the R. W. Wood Prize (with A. Ekimov and A. Efros) from the Optical Society of America (2006).

**Shuguang Zhang***Massachusetts Institute of Technology, USA*

Prof. Shuguang Zhang is at the Center for Biomedical Engineering and Center for Bits & Atoms, Massachusetts Institute of Technology. He received his B.Sc. from Sichuan University in China and Ph.D. in biochemistry and molecular biology from University of California at Santa Barbara. He was an American Cancer Society Postdoctoral Fellow at MIT and was a Whitaker Foundation Investigator. He is member of AAAS, American Society of Biochemistry & Molecular Biology, the Protein Society, New York Academy of Sciences, Sigma Xi. He received an honorary professorship from Sichuan University. He is also an elected Chang Jiang distinguished scholar in China. He is a 2003 Fellow of Japan Society for Promotion of Science (JSPS fellow). His work on the designer peptide scaffold won the 2004 R&D100 award. His and his colleagues' work on direct harvesting of biosolar energy was selected to be the Top 100 Science Stories in 2004 by Discover Magazine and one of the 10 finalists of the 2005 Saatchi & Saatchi Award for World Changing Ideas. He is one of the 2006 John Simon Guggenheim Fellows. He is the recipient of the 2006 Wilhelm Exner Medal of Austria.

**Tom Brown***University of Southampton, UK*

Prof. Tom Brown is the Head of the Synthesis Research group of the School of Chemistry, at the University of Southampton, UK. His research is focused on the synthesis of chemically modified oligonucleotides for the detection of specific PCR amplicons, the use of fluorescence in the measurement of the stability of nucleic acid structures and nucleic acid-drug complexes (with K.R.Fox), and the application of modified oligonucleotide in forensic and genetic DNA analysis. Prof. Brown is also interested in the synthesis of DNA triplex analogues for use in sequence-specific antigene and gene-correction applications (with Keith Fox) and studies on nucleic acid structure, DNA repair enzymes and DNA/anti-cancer drug complexes. More recently his research has also involved applications of novel aspects of oligonucleotide chemistry in the nanotechnology field. Prof. Brown was awarded a lectureship at the University of Edinburgh in 1985 after postdoctoral spells at Oxford and Cambridge Universities. He was promoted to Reader in 1991, then to Professor of Nucleic Acids Chemistry in 1993, having received both the Royal Society of Edinburgh MacDougall-Brisbane Prize for Research and the Royal Society of Chemistry Josef Loschmidt Award for research in Structural Chemistry in 1992. In 1993, he was awarded a Royal Society of Edinburgh Caledonian Research Fellowship. He moved to Southampton in 1995, where he became Professor of Bio-Organic Chemistry in the School of Chemistry. In 2004, he received a Royal Society Leverhulme Senior Research Fellowship for research on triplex-mediated DNA sequence recognition and in 2007 received the Royal Society of Chemistry award for Nucleic Acids Chemistry.



# ACKNOWLEDGMENTS

## SYMPOSIUM ORGANIZERS



The Institute of Bioengineering and Nanotechnology (IBN) is a member of the Agency for Science, Technology and Research (A\*STAR). Established in 2003, the institute's mission is to establish a broad knowledge base and conduct innovative research at the interface of bioengineering and nanotechnology. Positioned at the platforms that will spur the growth of new industries. IBN also fosters an exciting, multidisciplinary research environment for the training of students and young researchers to spearhead biomedical advancement in Singapore. For more information, please visit [www.ibn.a-star.edu.sg](http://www.ibn.a-star.edu.sg).



The Molecular Frontiers Foundation is a global think tank that seeks to promote the understanding and appreciation of molecular science in society. Its Scientific Advisory Board (SAB) consists of 7 Nobel Prize laureates as well as 19 distinguished scientists from various parts of the world. The Molecular Frontiers Foundation also focuses on engaging young people to pursue scientific enquiry and has recently incepted the Molecular Frontiers Inquiry Prize for youths. The Foundation was founded by Prof. Bengt Nordén, who is also the Chair of the Selection Committee of the Nobel Prize in Chemistry. For information about the Molecular Frontiers Foundation, visit [www.molecularfrontiers.org](http://www.molecularfrontiers.org).

## SYMPOSIUM COMMITTEE

### Symposium Chair

- Prof. Jackie Y. Ying

### Symposium Advisors

- Prof. Bengt Nordén
- Prof. Shuguang Zhang

### Local Organizing Committee Members

- Noreena AbuBakar (Chair)
- Nidyah Sani
- Laura Lau
- Jeewon Chung
- Diana Sani
- Lydia Sum

## SPONSORS

### Sponsors



Institute of  
Bioengineering and  
Nanotechnology



Biomedical  
Research Council



Agency for  
Science, Technology  
and Research

### Co-Sponsors



NANYANG  
TECHNOLOGICAL  
UNIVERSITY



NUS  
National University  
of Singapore

### Associate Sponsors



NUS  
National University  
of Singapore

DEPARTMENT OF CHEMISTRY  
FACULTY OF SCIENCE



### Lanyard Sponsor



### Venue Sponsor



### Exhibitors

- Invitrogen Singapore Pte Ltd
- Multi Universal Instrument Pte Ltd
- Carl Zeiss Pte Ltd
- Sigma-Aldrich Pte Ltd
- Singapore Oxygen Air Liquide Pte Ltd
- PharmaAsia
- Asia Pacific Biotech News