CHEMISTRY: PERSPECTIVES FOR THE FUTURE

International Symposium

October 12 (Wed), **2016**
APEC Hall (205), **BEXCO**

1946-2016 KCS 70th 대한화학회 70주년 KOREAN CHEMICAL SOCIETY

1976-2016 KRICT 40th 한국화학연구원 40주년 Korea Research Institute of Chemical Technology

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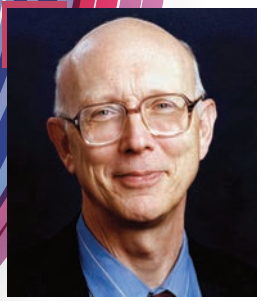
1976-2016 KRICT 40th 한국화학연구원 40주년 Korea Research Institute of Chemical Technology

"Chemistry : Perspectives for the Future"

October 12 (Wed), **13:00–18:20**

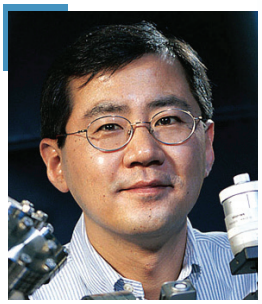
BEXCO, **Busan**



George M. Whitesides
Harvard University

Omar M. Yaghi
University of California, Berkeley

Amir H. Hoveyda
Boston College



Hongkun Park
Harvard University

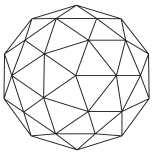
Tetsuro Majima
Osaka University

Eduard Arzt
Leibniz Institute for New Materials

CHEMISTRY: PERSPECTIVES FOR THE FUTURE

International Symposium

Contents



Program Overview

Chemistry: Perspectives for the Future

Chair in General; Seung Bum Park (Seoul National University)

13:00-13:30	Celebration of KCS 70th Anniversary and KRICT 40th Anniversary
	Opening Address : Chang-Hee Lee (President, Korean Chemical Society)
	Welcoming Address : Kew-Ho Lee (President, Korea Research Institute of Chemical Technology)
	Congratulatory Address : Sangchun Lee (Chairman, National Research Council of Science & Technology) : Yung Bog Chae (Former President, Korean Chemical Society: Korea Research Institute of Chemical Technology)
Session 1	**Chair; Jong Seung Kim (Vice President, Korean Chemical Society)**
13:30-14:10	George M. Whitesides (Harvard University) Simple/Low-cost Bioanalysis for the Developing World and Point of Care
14:10-14:50	Tetsuro Majima (Osaka University) Single-Molecule, Single-Particle Chemistry of Nanocatalysts for Light Energy Conversion
14:50-15:30	Hongkun Park (Harvard University) Nanoscale Gems, Needles and Grooves: New Material Platforms for Physical and Life Science Research
15:30-16:10	Coffee Break
Session 2	**Chair; Chang Jin Lee (Division Director for the Research Planning & Management Division, Korea Research Institute of Chemical Technology)**
16:10-16:50	Eduard Arzt (Leibniz Institute for New Materials) Bioinspired Functional Surfaces – A Challenge for Interdisciplinary Materials Research
16:50-17:30	Amir H. Hoveyda (Boston College) Necessity for Sophisticated Chemical Synthesis: Doing What we Must, Not What we Can
17:30-18:10	Omar M. Yaghi (University of California, Berkeley) Stitching and Weaving of Molecules into New Materials
18:10-18:20	Closing Remarks : Hakwon Kim (Vice President, Korean Chemical Society)

Symposium Banquet is scheduled at 6:30 PM at the 3rd Floor Lobby of the BEXCO Convention Center.
All participants are welcomed.

Opening Address

Chang-Hee Lee
President
Korean Chemical Society

Dear Colleagues,

It is my great pleasure to welcome you to the International Symposium on *"Chemistry: Perspectives for the Future"*, which is held at the Busan Convention Center (BEXCO) on October 12, 2016. This special event is to celebrate the 70th anniversary of Korean Chemical Society (KCS) and the 40th anniversary of Korea Research Institute of Chemical Technology (KRICT).

Established in 1946, KCS has played a pivotal role in the remarkable growth of the chemistry community in Korea over the years. As the oldest scientific society in Korea, which represents both basic and applied chemical sciences, our mission is maintaining a collegial and collaborative relationship while enhancing its status as a responsible member of the world's chemistry community. This year marks the 70th anniversary of KCS. I am confident that the best is yet to come, and very much look forward to another 70 years of flourishing chemistry.

I would like to express my gratitude to the speakers who wholeheartedly accepted our invitations. I am also grateful to the representatives of international chemical societies, including Chemical Society of Japan, Chinese Chemical Society and German Chemical Society who are joining us in this memorable event. We will continue to build strong collaborative relationships with you. Finally, I thank all of you for your attendance, and very much look forward to exciting discussions on how chemistry would lead us toward a sustainable future.

Thank you.

Welcoming Address

Kew-Ho Lee
President
Korea Research Institute of
Chemical Technology

We are pleased to invite you to the International Symposium on *"Chemistry: Perspectives for the Future"* which will take place on October 12, 2016, at BEXCO in Busan commemoration of the 70th anniversary of Korean Chemical Society (KCS) and the 40th anniversary of Korea Research Institute of Chemical Technology (KRICT).

Since its establishment in 1976 as a government research institute, KRICT has fueled the growth of Korea's chemical industry and thus contributed to the national development. We believe that the future of Korea also lies in chemical technology, which serves as the foundation for future convergence.

In this context, the symposium is timely to bring together researchers and experts from and outside Korea to share their visions for future in the perspective of chemistry. We have invited world's leading figures in the field of chemistry to share their views and expertise.

We are confident that distinguished participants here today will seize the momentum and continue their leadership in chemistry together with KCS and KRICT. We once again appreciate all of your participation and wish you all the best in the future.

Thank you.

Congratulatory Address

Sangchun Lee

Chairman
National Research Council of
Science & Technology

Honorable Dr. Yung Bog Chae, Former Minister of Science and Technology,
Dr. Kew-Ho Lee, President of Korea Research Institute of Chemical Technology,
Dr. Chang-Hee Lee, President of Korean Chemical Society,
Distinguished speakers and participants,
Ladies and gentlemen,

It is my great pleasure to congratulate this special occasion of the International Symposium, which is such a meaningful commemoration for the 40th anniversary of Korea Research Institute of Chemical Technology (KRICT) and the 70th anniversary of Korean Chemical Society (KCS). I would also like to pay my highest tribute to KRICT and KCS for their valuable efforts in leading the development of Korea's chemical industry. I believe that we all attending here are sharing the pleasure to congratulate this meaningful occasion with the world's leading experts and distinguished participants.

Ladies and gentlemen,
Korea has achieved phenomenal economic development in the last 50 years driven by science and technology. In particular, the chemical industry has been one of the most important driving forces of this achievement, and KRICT and KCS have been in the center of this significant contributions. KRICT has led the growth of Korea's chemical industry by developing chemical and relevant technologies, transferring those technologies to the industry, and nurturing professionals in the field of chemistry. We all will agree that KCS has played a key role in the history of Korea's chemical society by advancing academic and technological aspects of chemistry. This symposium, in this context, is timely to commemorate the history and bring together the views and expertise of the world's leading figures in chemistry.

Ladies and gentlemen,
National Research Council of Science & Technology has been in stance of strong support to KRICT and KCS, and will keep on supporting for their further achievement and advancement of Korea's chemical industry. Once again, I would like to appreciate the 40th anniversary of KRICT and the 70th of KCS, and wish all of you the best and success.

Thank you.

Congratulatory Address

Yung Bog Chae

Former President
Korean Chemical Society;
Korea Research Institute of
Chemical Technology

It is my personal honor to deliver congratulatory remarks in this International Symposium to celebrate the 70th Anniversary of Korean Chemical Society (KCS) and the 40th Anniversary of Korea Research Institute of Chemical Technology (KRICT). This particular event is all the more meaningful to me, since I had the privilege of serving as the President of both KCS (1994–1995) and KRICT (1982–1993).

As an enabling science, chemistry has driven the development of human culture and enhanced our quality of life. It has also served as a firm foundation for other branches of basic and applied sciences. Chemistry will continue to play a central role in tackling challenges that we face with increasing human population, including environmental damage, climate change, energy problem, water shortage, and human disease. It is time for the chemists across the globe to make collective efforts toward a safer and sustainable future.

Looking back over the past seven decades since Korea reclaimed its sovereignty, it is remarkable that we have risen up to become the world's fifth-largest chemical producer as of now. Essentially starting from ground zero, chemical research in Korea has also made equally impressive advances during that period. Now it is time for us to place more emphasis on quality, rather than mere quantity, of academic research outputs and technological innovations in chemical industry.

I sincerely hope that this International Symposium will serve as an excellent forum to discuss current challenges and future perspectives of chemistry. I am grateful to all the renowned speakers, delegates, and guests who are participating in this event, and would like to send my best wishes.

Thank you.

Session 1

Chair: Jong Seung Kim

(Vice President, Korean Chemical Society)

George M. Whitesides (Harvard University)

Tetsuro Majima (Osaka University)

Hongkun Park (Harvard University)

George M. Whitesides
Harvard University

Education

Ph.D. (1964)	Department of Chemistry, California Institute of Technology
A.B. (1960)	Harvard University

Major Activities

1982-present	Professor, Harvard University
2004-present	Woodford L. and Ann A. Flowers University Professor, Harvard University
1982-2004	Mallinckrodt Professor of Chemistry, Harvard University
1986-1989	Department Chairman, Harvard University
1963-1982	Professor, Massachusetts Institute of Technology

Qualifications and Awards

2013	Gold Medal (Industrial Research Institute)
2009	Benjamin Franklin Medal in Chemistry (Franklin Foundation)
2007	American Institute of Chemists Gold Medal
2007	Priestley Award (American Chemical Society)
2005	2004 Dickson Prize in Science (Carnegie Mellon University)
2002	Small Times Magazine's Researcher of the Year Award
1998	U.S. National Medal of Science
1995	Arthur C. Cope Award (ACS)
1989	Arthur C. Cope Scholar Award (ACS)
1975	American Chemical Society (ACS) Award in Pure Chemistry

Representative Publications

1. "Tilted Magnetic Levitation Enables Measurement of the Complete Range of Densities of Materials with Low Magnetic Permeability" *J. Am. Chem. Soc.* **2016**, *138,* 1252-1257.
2. "Density-Based Separation in Multiphase Systems Provides a Simple Method to Identify Sickle Cell Disease" *PNAS,* **2014**, *111,* 14864-14869.
3. "Camouflage and Display for Soft Machines" *Science,* **2012**, *337,* 828-832.
4. "Lysine Acetylation can Generate Highly Charged Enzymes with Increased Resistance Towards Irreversible Inactivation" *Science,* **2008**, *17,* 1446-1455.
5. "Coding/Decoding and Reversibility of Droplet Trains in Microfluidic Networks" *Science,* **2007**, *315,* 828-832.
6. "Polymer Microstructures Formed by Moulding in Capillaries" *Nature,* **1995**, *376,* 581-584.
7. "Complexity in Chemistry" *Science,* **1999**, *284,* 89-92.
8. "Orthogonal Systems for Self-Assembled Monolayers: Alkanethiols on Gold and Alkane Carboxylic Acids on Alumina" *Science,* **1989**, *245,* 845-847.
9. "The Location and Mobility of Functional Groups at the Surface of Oxidized, Low-Density Polyethylene Film" *J. Am. Chem. Soc.* **1977**, *99,* 4746-4756.

Simple/Low-cost Bioanalysis for the Developing World and Point of Care

George M. Whitesides
Department of Chemistry, Harvard University
12 Oxford Street, Cambridge, MA 02138, USA
gwhitesides@gmwgroup.harvard.edu

This talk will describe exploratory research designed to develop systems based on first-world science to solve diagnostic problems in resource-limited environments, and to provide tools for public health. The work focuses on bioanalytical systems for diagnostics, and includes work on paper diagnostics, magnetic levitation, two-phase polymer systems, and electrochemistry. The program also has an unusual component, in asking what strategies in academic research will be most successful in converting results from university bench science into real solutions to problems in health in the hands of users.

Tetsuro Majima
Osaka University

Education

Ph.D. (1980)	Department of Petroleum Chemistry, Osaka University
M.S. (1977)	Department of Petroleum Chemistry, Osaka University
B.S. (1975)	Department of Petroleum Chemistry, Osaka University

Major Activities

1997-present	Professor, The Institute of Scientific and Industrial Research, Osaka University
1994-1997	Associate Professor, The Institute of Scientific and Industrial Research, Osaka University
1992-1994	Senior Researcher, The Institute of Physical and Chemical Research (RIKEN)
1983-1992	Researcher, The Institute of Physical and Chemical Research (RIKEN)
1982-1983	Guest Researcher, The Institute of Physical and Chemical Research (RIKEN)
1980-1982	Research Associate, University of Texas at Dallas (Prof. Richard A. Caldwell)

Qualifications and Awards

2016-present	Co-Chair of *ChemPlusChem,* Wiley VHC
2015-present	Cooperative Professor, Shanghai Normal University
2012-present	Outstanding Overseas Scholar, Shanghai University of Electric Power
2011-present	Guest Professor, Shanghai University
2016	Chairperson of 26th IUPAC International Symposium on Photochemistry
2014	Japanese Society of Radiation Chemistry, Award
2007-2014	Senior Editor of *Langmuir*, American Chemical Society.
	Associate Editor of *Photochemistry and Photobiology,* Wiley VHC
2011-2013	President of the Asia Oceania Society on Photobiology
2009-2013	WCU Adjunct Professor, Korea University
2011-2012	President of the Photobiology Association of Japan
2000, 2008	The Japanese Photochemistry Association, Award and Lectureship Award
	The Chemical Society of Japan, BCSJ Award

Representative Publications

1. "Nanoplasmonic Photoluminescence Spectroscopy at Single-Particle Level: Sensing for Ethanol Oxidation" *Angew. Chem. Int. Ed.* **2016**, *55, 2879-2883.*
2. "A Nanocomposite Superstructure of Metal Oxides with Effective Charge Transfer Interfaces" *Nat. Commun.* **2014**, *5,* 4038/1-4038/9.
3. "Evidence for Crystal-Face-Dependent TiO_2 Photocatalysis from Single-Molecule Imaging and Kinetic Analysis" *J. Am. Chem. Soc.* **2011**, *133,* 7197-7204.
4. "Sequence Independent Rapid Long-Range Charge Transfer through DNA" *Nat. Chem.* **2009**, *1,* 156-159.
5. "Two-Laser-Guided Three-Dimensional Microfabrication and Processing in Flexible Polymer Matrix" *Adv. Mater.* **2008**, *20,* 3427-3432.
6. "Direct Observation of Hole Transfer through Double Helical DNA over 100 Å" *Proc. Nat. Acad. Sci. USA* **2004**, *101,* 14002-14006.

Single-Molecule, Single-Particle Chemistry of Nanocatalysts for Light Energy Conversion

Tetsuro Majima
The Institute of Scientific and Industrial Research (SANKEN), Osaka University,
Mihogaoka 8-1, Ibaraki, Osaka 567-0047, Japan
majima@sanken.osaka-u.ac.jp

To design an efficient light energy conversion system, it is important to reveal and understand the molecular interactions and the mechanism of chemical reactions at the heterogeneous interfaces. We have investigated the light energy conversion processes occurring on a variety of nanocatalysts using single-molecule, single-particle fluorescence imaging techniques, and gained information related to spatial and temporal heterogeneities in reactions, which are always masked by ensemble averaging.

We synthesized novel fluorogenic probes to selectively observe the catalytic reactions. Such probes are designed to become fluorescent upon the reaction with target species under photoirradiation. The position of individual fluorescent products can be determined with several tens of nanometers of spatial resolution by two-dimensional Gaussian fitting. In addition, the quantitative analysis of fluorescence intensity trajectory or fluctuation can reveal the underlying properties of individual catalysts.

We prepared nanometer- and micrometer-sized crystals of photoactive metal oxide semiconductors, such as titanium dioxide and bismuth vanadium oxide, and explored the photocatalytic reactions on individual catalysts by single-molecule fluorescence microscopy with newly developed redox-responsive fluorogenic probes. The effects of probe concentration, solvent, pH, and light intensity will be examined to optimize the experimental conditions. From the analysis of spatial distribution of reactive sites, the relationship between surface structures and chemical reactivity is elucidated. From the quantitative analysis of on/off duration times, we further determined the turnover frequency of individual catalysts, adsorption and dissociation rates, interfacial electron transfer rates, and temporal fluctuation of reaction efficiency.

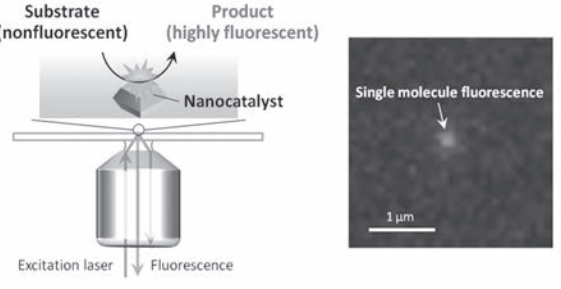
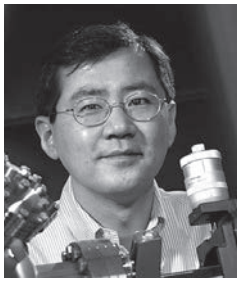


Figure 1
Single-molecule fluorescence imaging of photocatalytic reactions.

The photochemical reaction dynamics of metal nanoparticles and various nanostructured materials are also studied at the ensemble and single-molecule and single-particle levels with the aid of quantum calculations to examine their possible use as nanocatalysts. We believe the proper understanding of structures and reactions at heterogeneous interfaces leads to the emerging applications of nanocatalysts for environmentally and economically sustainable uses.



Hongkun Park
Harvard University

Education

Ph.D. (1996)	Stanford University
B.S. (1990)	Seoul National University

Major Activities

2015-present	Institute Member, Broad Institute of Harvard and MIT
2004-present	Professor, Chemistry and Physics, Harvard University
2003	John L. Loeb Associate Professor of the Natural Sciences, Harvard University
2003-2004	Associate Professor, Chemistry, Harvard University
1999-2003	Assistant Professor, Chemistry, Harvard University
1996-1999	Postdoctoral Fellow, Lawrence Berkeley National Laboratory

Qualifications and Awards

2016	Vannevar Bush Faculty Fellow
2011	Fellow, American Association for the Advancement of Science
2008	NIH Director's Pioneer Award
2004	Fellow, The World Technology Network
2003	Ho-Am Prize for Science
2003	Visiting Miller Research Professorship, UC Berkeley
2002	Alfred P. Sloan Foundation Research Fellowship
2001	David and Lucile Packard Foundation Fellowship for Science and Engineering
2001	NSF CAREER Award
1991	Graduate Fellow, The Korea Foundation for Advanced Studies
1990	Presidential Prize and Valedictorian, Seoul National University

Representative Publications

1. "Nuclear Magnetic Resonance Detection and Spectroscopy of Single Proteins Using Quantum Logic" *Science,* **2016**, *351,* 836-841.
2. "Visible-Frequency Hyperbolic Metasurface" *Nature,* **2015**, *522,* 192-196.
3. "Single-Cell Genomics Unveils Critical Regulators of Th17 Cell Pathogenicty" *Cell,* **2015**, *163,* 1400-1412.
4. "Magnetic Resonance Detection of Individual Proton Spins Using Quantum Reporters" *Phys. Rev. Lett.* **2014**, *113,* 197601.
5. "Single-Cell Transcriptomics Reveals Bimodality in Expression and Splicing in Immune Cells" *Nature,* **2013**, *498,* 236-240.
6. "Nanometer-Scale Thermometry in a Living Cell" *Nature,* **2013**, *500,* 54-59.
7. "Tailoring Light-Matter Interaction with a Nanoscale Plasmon Resonator" *Phys. Rev. Lett.* **2012**, *108,* 226803.
8. "Vertical Nanowire Electrode Arrays as a Scalable Platform for Intracellular Interfacing to Neuronal Circuits" *Nature Nanotech.* **2012**, *7,* 180-184.
9. "Vertical Silicon Nanowires as a Universal Platform for Delivering Biomolecules into Living Cells," *Proc. Natl. Acad. Sci. USA,* **2010**, *107,* 1870-1875.
10. "Near Field Electrical Detection of Optical Plasmons and Single Plasmon Sources" *Nature Phys.* **2009**, *5,* 475-479.

Nanoscale Gems, Needles and Grooves: New Material Platforms for Physical and Life Science Research

Hongkun Park
Department of Chemistry and Chemical Biology and Department of Physics, Harvard University
Broad Institute of Harvard and MIT
12 Oxford Street, Cambridge, MA 02138, USA
Hongkun_Park@harvard.edu

My laboratory leverages our chemistry expertise to develop new nanoscale materials and tools and apply them to a variety of problems ranging from quantum information processing, plasmonics, nano-bio interfacing, all the way to single-cell sequencing. In this presentation, I will describe recent examples of such efforts based on three nanoscale structures – diamond nanocrystals, silicon needles and silver grooves – and how we use them to address various problems in physical and life sciences. First, I will discuss our efforts to combine two-dimensional plasmonic crystals and metasurfaces, silicon-vacancy centers in nanostructured diamond, and two-dimensional transition metal dichalcogenides to realize integrated all-optical devices and logic circuits that work all the way down to the single-photon level. Next, I will present diamond nanocrystals containing the nitrogen-vacancy color centers: these nanocrystals can not only serve as solid-state atom-like qubits that can be coupled to the photonic/plasmonic structures, but also function as ultrasensitive electromagnetic and temperature sensors that can be coupled to living systems. Finally, I will discuss a CMOS-nanoneedle electrode array that enables highly multiplexed interrogation and manipulation of mammalian cells in a minimally invasive fashion. These examples illustrate how the developments of new nanoscale structures and tools enable new lines of scientific inquiries.

Session 2

Chair: Chang Jin Lee

(Division Director for the Research Planning & Management Division, Korea Research Institute of Chemical Technology)

Eduard Arzt (Leibniz Institute for New Materials)

Amir H. Hoveyda (Boston College)

Omar M. Yaghi (University of California, Berkeley)

Eduard Arzt
Leibniz Institute for New Materials

Education

Ph. D. (1980) University of Vienna
B.S. and M.S. (1974-1980) University of Vienna

Major Activities

2007-present	Scientific Director and Chairman, Leibniz Institute for New Materials
	Saarbrücken Chair for New Materials, Saarland University
1990-2007	Director, Max Planck Institute for Metals Research, Stuttgart
	Joint Appointment as Professor of Metals Physics, University of Stuttgart
1989-1990	Visiting Professor, Stanford University
1982-1989	Group Leader, Max Planck Institute for Metals Research, Stuttgart
1981-1982	Postdoctoral Fellow, Department of Engineering, Cambridge University

Qualifications and Awards

2010-present	Chairman, Scientific Advisory Board, NANOMICRO Programme, Karlsruhe Institute of Technology
1996	Gottfried Wilhelm Leibniz Award (Highest German Science Award)
1991	Max Planck Research Award
1990	Acta Materialia Outstanding Paper Award

Representative Publications

1. "Fibrillar Elastomeric Micropatterns Create Tunable Adhesion Even to Rough Surfaces" *Advanced Functional Materials,* **2016***, 26,* 4687-4694.
2. "Temperature-Induced Switchable Adhesion Using Nickel-Titanium-Polydimethylsiloxane Hybrid Surfaces" *Advanced Functional Materials,* **2015***, 25,* 3013-3021.
3. "Single Macroscopic Pillars as Model System for Bioinspired Adhesives: Influence of Tip Dimension, Aspect Ratio and Tilt Angle" *ACS Applied Materials & Interfaces,* **2014***, 6,* 7076-7083.
4. "Observation of Giant Diffusivity along Dislocation Cores" *Science,* **2008***, 319,* 1646-1649.

Bioinspired Functional Surfaces - A Challenge for Interdisciplinary Materials Research

Eduard Arzt
Scientific Director and Chairman (CEO), INM - Leibniz Institute for New Materials
Professor for New Materials, Saarland University, Campus D2 2, 66123 Saarbruecken, Germany
Eduard.Arzt@leibniz-inm.de

New surfaces and coatings can drastically improve the properties and applicability of materials. At INM, we develop and investigate new dynamic surfaces for diverse functionalities: low friction, adhesion, corrosion protection, anti-reflection, electric storage and combinations of these. Such surfaces either exhibit new chemistries or new fibrillar topographies, sometimes on different hierarchical levels. I will give an overview of some of our recent developments in these areas. Then I will highlight our bio-inspired exploitation of the “gecko effect”: after research over more than a decade, also on living animals, we are now in a position to artificially produce and optimize such surface protrusions to create also switchable functionalities. Recently, we investigated such features numerically by considering the micromechanics of detachment of single elastic fibrils from an elastic half-space; the simulations now guide the fabrication of such surfaces with promising applications in robotics, sports devices and biomedicine.

Amir H. Hoveyda
Boston College

Education

Ph.D. (1986)	Department of Chemistry, Yale University
B.A. (1981)	Department of Chemistry, Columbia University

Major Activities

1998-present	Patricia and Joseph T. '49 Millennium Professor of Chemistry, Boston College
1994–1998	Professor, Boston College
1990–1994	Assistant Professor, Boston College
1986-1990	Postdoctoral Fellow, Department of Chemistry, Harvard University

Qualifications and Awards

2014	Eni Prize
2014	American Chemical Society, Award for Creative Work in Organic Synthesis
2010	Yamada-Koga Prize
1998	American Chemical Society, Cope Scholar Award
1994	Camille Dreyfus Teacher-Scholar Award
1994	Alfred P. Sloan Research Fellowship
1992	National Science Foundation, National Young Investigator Award

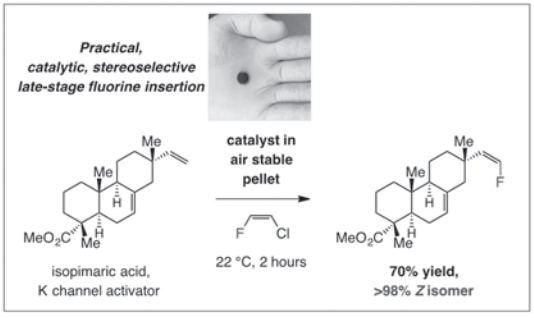
Representative Publications

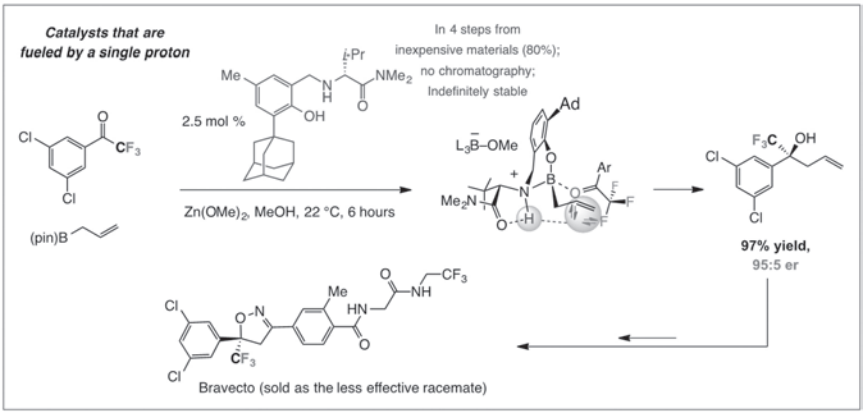
1. "Catalytic Enantioselective 1,6-Conjugate Additions of Propargyl and Allyl Groups" *Nature,* **2016** *Nature, 2016, 537,* 387-393.
2. "Multifunctional Organoboron Compounds for Scalable Natural Product Synthesis" *Nature,* **2014**, *513,* 367-374.
3. "Readily Accessible and Easily Modifiable Ru-Based Catalysts for Efficient and Z-Selective Ring-Opening Polymerization and Ring-Opening Metathesis" *J. Am. Chem. Soc.* **2013**, *135,* 10258-10261.
4. "Synthesis of Macrocyclic Natural Products by Catalyst-Controlled Stereoselective Ring-Closing Metathesis" *Nature,* **2011**, *479,* 88-93.
5. "Catalytic Z-Selective Olefin Cross-Metathesis for Natural Product Synthesis" *Nature,* **2011**, *471,* 461-466.
6. "A New Class of Chiral Catalysts for Enantioselective Olefin Metathesis" *Nature,* **2008**, *456,* 933-937.
7. "Enantioselective Silyl Protection of Alcohols Catalysed by an Amino Acid-Based Small-Molecule" *Nature,* **2006**, *443,* 67-70.
8. "Efficient and Recyclable Monomeric and Dendritic Ru-Based Metathesis Catalysts" *J. Am. Chem. Soc.* **2000**, *122,* 8168-8179.
9. "Catalytic Enantioselective Ring-Closing Metathesis by a Chiral Biphen-Mo Complex" *J. Am. Chem. Soc.* **1998**, *120,* 4041-4042.

Necessity for Sophisticated Chemical Synthesis: Doing What we Must, Not What we Can

Amir H. Hoveyda
Boston College, Merkert Chemistry Center, Chestnut Hill, Massacussetts 02467, USA
amir.hoveyda@bc.edu

Chemical synthesis, while enabling us to access molecules as efficiently as possible, can expand our understanding of the fundamental principles of reactivity and selectivity. It gives us the opportunity of examining molecules that we imagine to be special and brings us molecules that are on our "wish list" – it gives us the opportunity to wonder "what if?". Significant advances have indeed been achieved, but to consider the whole of organic synthesis a consummated field would be akin to suggesting to the great Henry Ford that his model T was the be-all and end-all in automobile making. It is likely true that an expert chemist, given sufficient amount of time and funds, could prepare almost any molecule in a specially-equipped laboratory, but often only as morsels, after suffering countless wrong turns and myriad dead-ends. For synthetic chemistry to provide the impact that it can many crucial advances must be realized. This lecture will focus on some of these issues.





Omar M. Yaghi
University of California, Berkeley

Education

Ph.D. (1990)	University of Illinois-Urbana
B.S. (1985)	State University of New York-Albany

Major Activities

2014-present	Co-Director, California Research Alliance by BASF, UC Berkeley
2014-present	Co-Director, UC Berkeley-KACST Collaborative Science Center
2014-present	Founding Director, Global Science Institute, UC Berkeley
2014-present	Associate Editor, Journal of the American Chemical Society
2013-present	Co-Director, Kavli Energy Nanosciences Institute, UC Berkeley
2012-present	James and Neeltje Tretter Chair Professor of Chemistry, University of California, Berkeley
2012-present	Faculty Scientist, Materials Sciences Division, Lawrence Berkeley National Laboratory
1990-1992	NSF Postdoctoral Fellow, Harvard University

Qualifications and Awards

2015	Mustafa Prize in Nanoscience and Nanotechnology
2015	King Faisal International Prize in Science
2012	World Class Talent 1000 Professorship, China
2011	Thomson Reuters Citation Laureate: Top 2 Most Cited Chemist Worldwide
2010	Royal Society of Chemistry Centenary Prize, UK
2009	World Class Professor, Korea
2009	American Chemical Society, ACS Award in the Chemistry of Materials
2008	AAAS Newcomb Cleveland Prize for the Most Outstanding Paper in Science
2006	The “Brilliant 10” Scientists and Engineers (Popular Science Magazine, 2006)
1997	NSF Faculty Early Career Development Award

Representative Publications

1. “Weaving of Organic Threads into a Crystalline Covalent Organic Framework” *Science,* **2016***, 351,* 365-369.
2. “Extra Adsorption and Adsorbate Superlattice Formation in Metal-Organic Frameworks” *Nature,* **2015***, 527,* 503-507.
3. “The Chemistry and Applications of Metal-Organic Frameworks” *Science,* **2013***, 341,* 1230444.
4. “Large-Pore Apertures in a Series of Metal-Organic Frameworks” *Science,* **2012***, 336,*1018-1023.
5. “Colossal Cages in Zeolitic Imidazolate Frameworks as Selective Carbon Dioxide Reservoirs” *Nature,* **2008***, 453,* 207-211.
6. “Designed Synthesis of 3D Covalent Organic Frameworks” *Science,* **2007***, 316,* 268-272.
7. “Porous, Crystalline, Covalent Organic Frameworks” *Science,* **2005***, 310,* 1166-1170.
8. “Reticular Synthesis and the Design of New Materials” *Nature,* **2003***, 423,* 705-714.
9. “Design and Synthesis of an Exceptionally Stable and Highly Porous Metal-Organic Framework” *Nature,* **1999***, 402,* 276-279.

Stitching and Weaving of Molecules into New Materials

Omar M. Yaghi
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yaghi@berkeley.edu

The most important materials humanity has known are made entirely from either organic or inorganic components. Until recently the development of crystalline materials in which organic and inorganic are combined remained largely unexplored. This presentation will discuss the key developments in the discovery of new materials based on stitching and weaving organic and inorganic molecules into framework structures – the arts and sciences of Reticular Chemistry, and highlight how this class of new crystalline materials has come to represent the largest class of materials ever made and currently being pursued by academia and industry.

Specifically, the chemistry of metal-organic frameworks (MOFs) and covalent organic frameworks (COFs) is based on linking molecular building units into extended covalent porous crystals using covalent bonds such as M – O, C – O, B – O, and C – N. These new classes of materials have many applications related to energy storage, carbon dioxide capture and conversion, super capacitors, to mention few. This presentation will also focus on the making of MOFs and COFs by covalent chemistry as well as the post synthesis covalent modification of these to produce precisely designed interiors capable of selective carbon dioxide capture, water capture from air to produce fresh water, and catalysis. The idea of incorporating sequences of chemical information within MOFs and COFs to code for specific properties will be discussed.

Solar Cell Materials

Reagent for Perovskite Solar Cells: Purified Lead(Ⅱ) Iodide

[L0279] Lead(Ⅱ) Iodide [for Perovskite precursor]
(99.99%, trace metals basis)

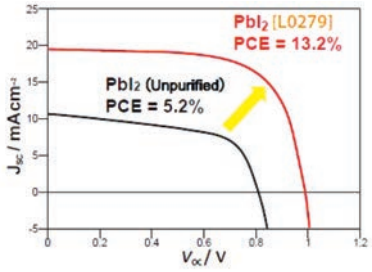
1G / 5G / 25G / 100G

Comparison of an existing product and [L0279]

PbI_2-DMF Solution

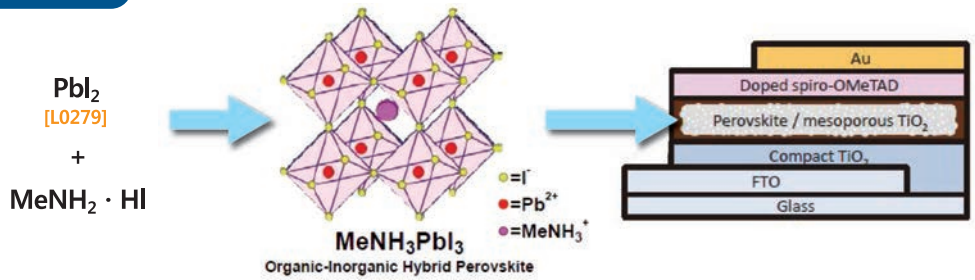
An existing product (Cloudy) [L0279] (Clear, 1M)

PCE



Application

Solution-processible perovskite solar cell device



A. Wakamiya, M. Endo, Y. Murata, Patent Pending, Appl. No. JP2014-008540, A. Wakamiya, M. Endo, T. Sasamori, N. Tokitoh, Y. Ogomi, S. Hayase, Y. Murata, Chem. Lett. **2014**, 43, 711, Y. Yamada, T. Nakamura, M. Endo, A. Wakamiya, Y. Kanemitsu, J. Am. Chem. Soc. **2014**, 136, 11610.

Advantages

- Lead(Ⅱ) Iodide with extremely low water quantity for preparing a concentrated clear DMF solution.
- Fabricates efficient perovskite solar cell devices (PCE > 10%) with high reproducibility.

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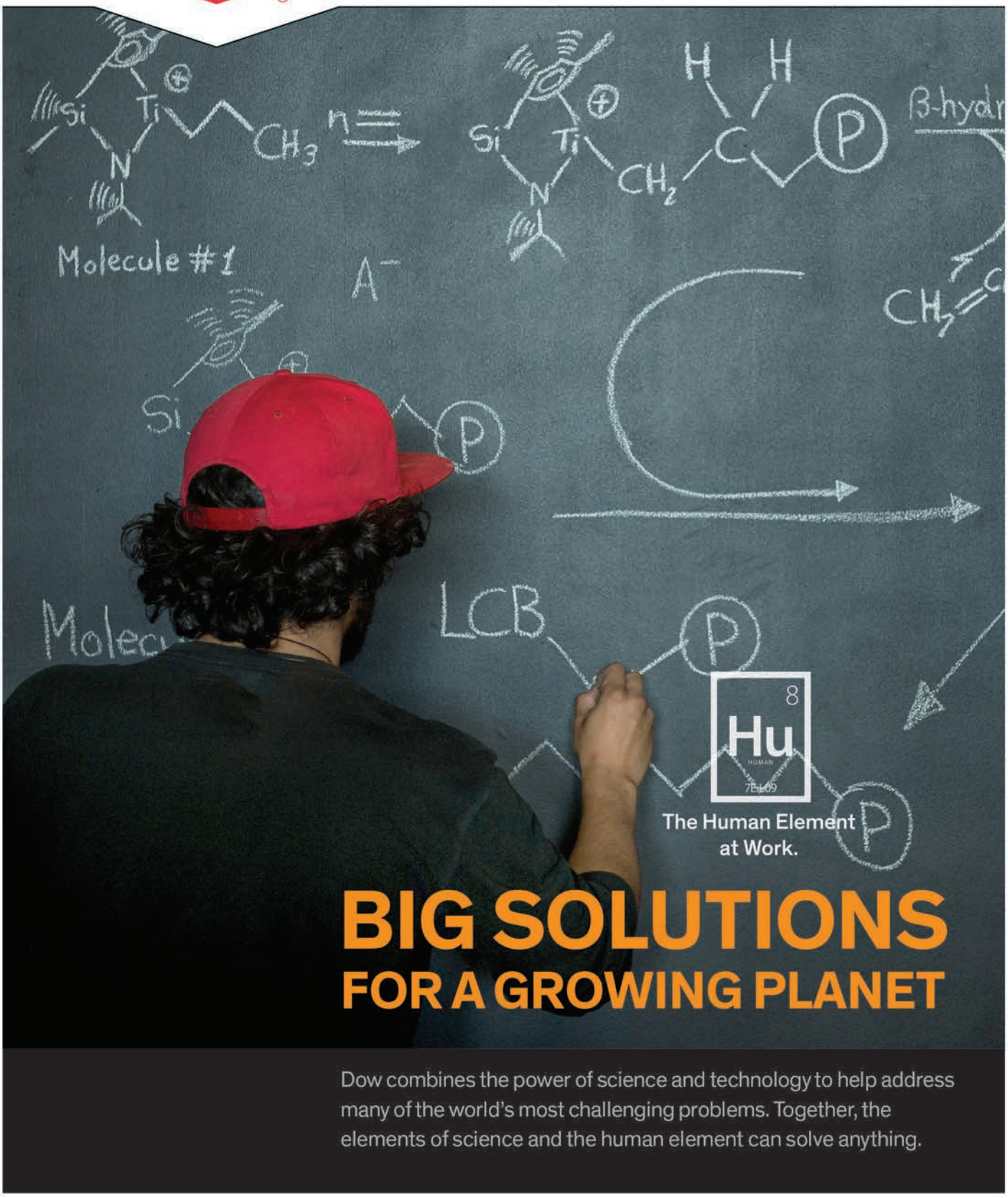

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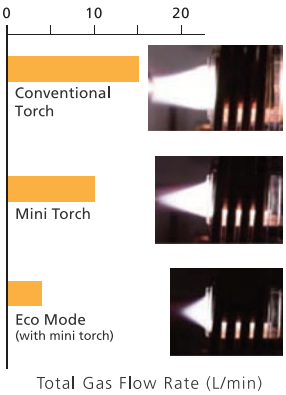

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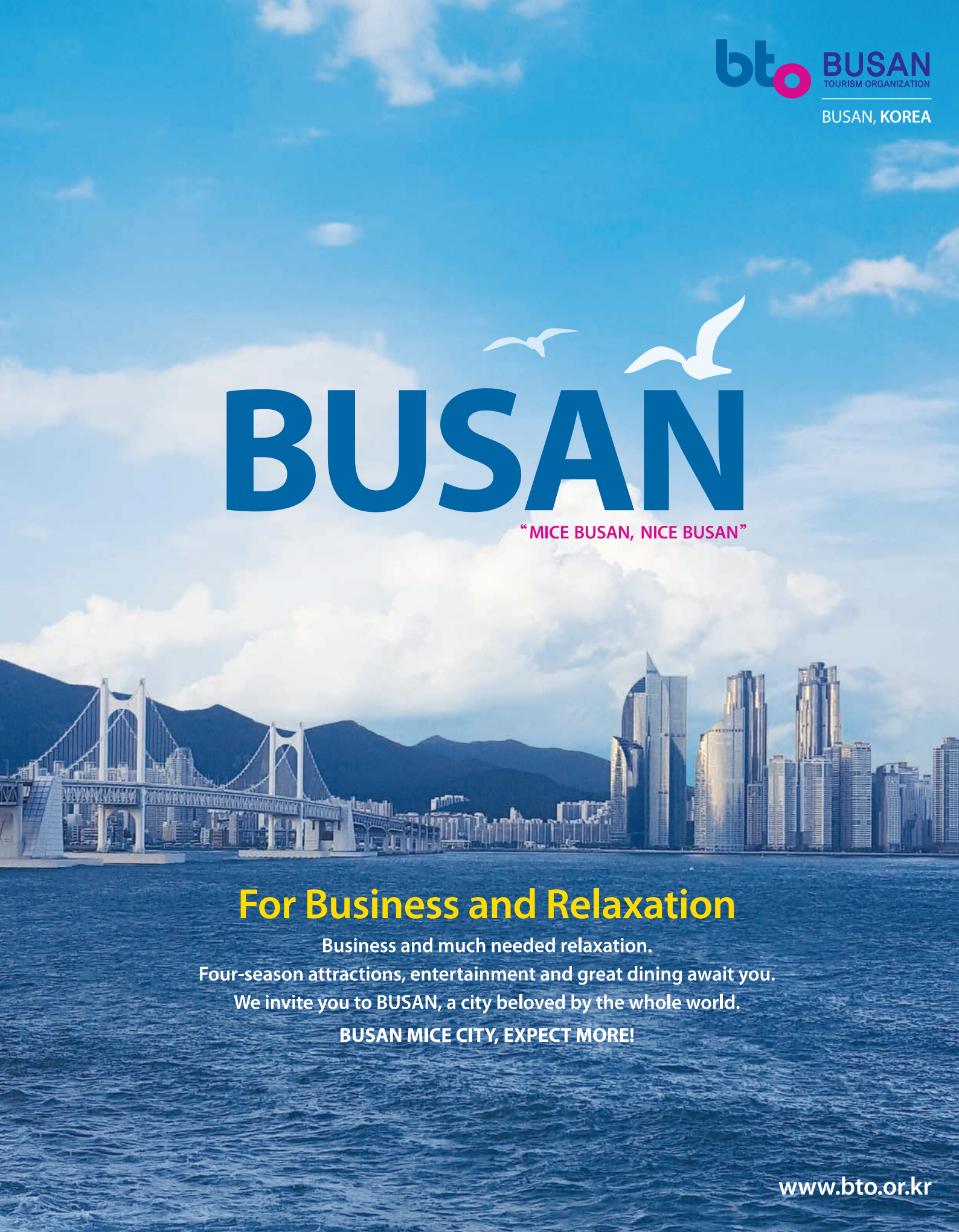
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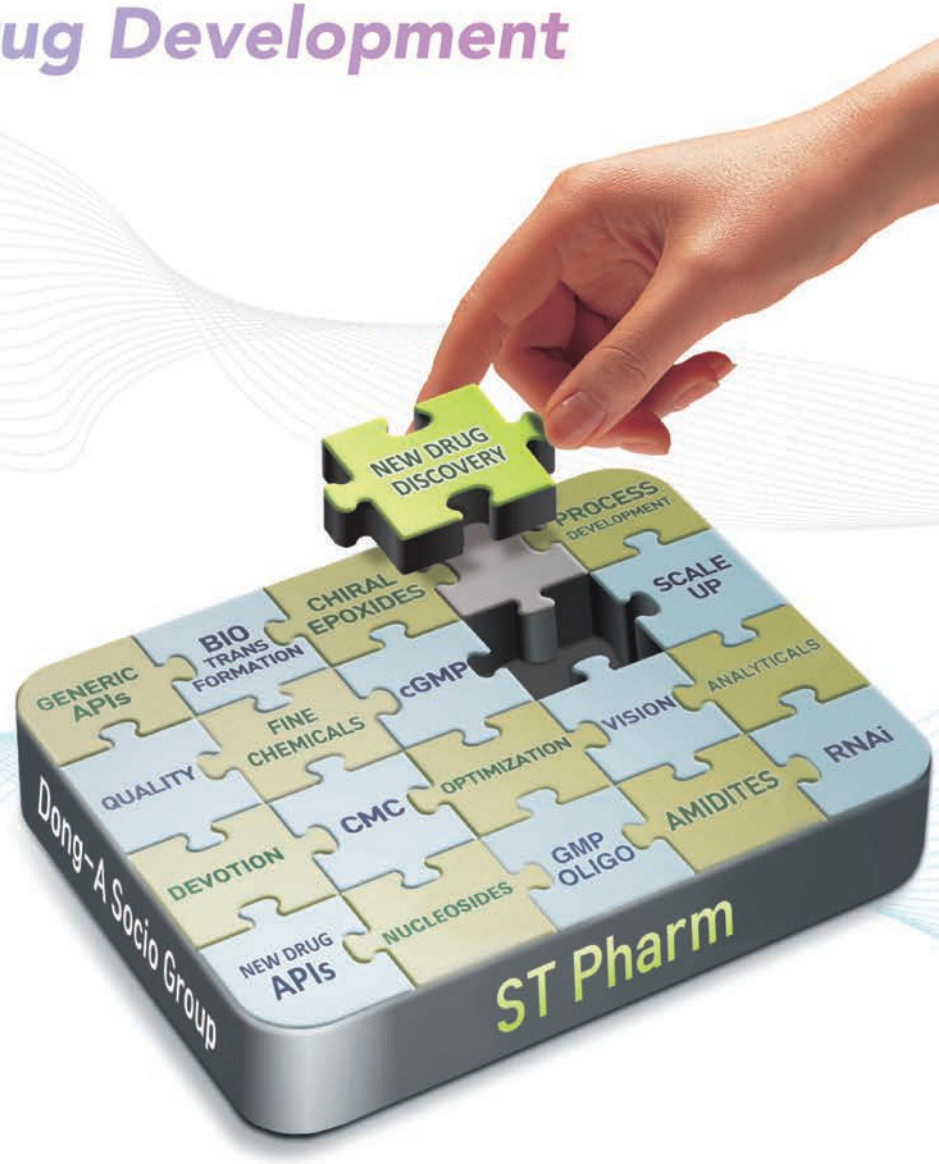

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