American Chemical Society's New York Section, Inc.
William H. Nichols Distinguished Symposium

" NANOSTRUCTURED POLYMERS BY MOLECULAR ENGINEERING USING ATRP "

Honoring

Professor Krzysztof Matyjaszewski

Friday, April 16, 2021

Free Virtual Symposium & Medal Award Ceremony

1:00 p.m. **Welcome**
Professor Ruben M. Savizky, 2020 Past Chair, ACS New York Section, The Cooper Union

1:05 p.m. **Opening of the Distinguished Symposium**
Professor Rita K. Upmacis, 2021 Chair, ACS New York Section, Pace University

1:15-2:00 p.m. **Polymer-Enhanced Biomacromolecules**
Dr. Alan J. Russell, Vice President Biologics, Amgen

The growth of polymers from the surface of proteins has opened the door to tuning and supplementing protein function by rational design. Protein-polymer conjugates are synthesized from pure starting materials and the struggle to separate conjugates from polymer, native protein, and from isomers has vexed scientists for decades. We have discovered that covalent polymer attachment has a transformational effect on protein function and opens the door to rational control of immunoisolation. Using a molecular dynamics guided approach, we have been able to design molecular sieves that can prevent protein-protein interactions while retaining function of a model protein with a small substrate. Polymer-based protein engineering is a powerful tool to combine the elegance of biology with the ruggedness of synthetic chemistry.

2:05-2:50 p.m. **Responsive Materials from Dynamic Bonds**
Professor Brent S. Sumerlin, Department of Chemistry, University of Florida

By relying on a variety of reversible covalent reactions that lead to readily cleaved bonds, we have prepared materials that combine the physical integrity of covalent materials and the structural dynamics of supramolecular complexes. Enaminone, boronic esters, boronate esters, and Diels-Alder linkages have all been employed to prepare these responsive and dynamic materials, with particular attention having been dedicated to the preparation of hydrogels, elastomers, and nanoparticles. We seek to exploit the reversible nature of these bonds to prepare responsive and self-healing materials.

2:55-3:35 p.m. **Dancing in the Dark with CHIPs: Polymers for Next Generation Photonics and Imaging**
Professor Jeffrey Pyun, Department of Chemistry and Biochemistry, University of Arizona

The ability to manipulate light with materials is critical for a wide range of optical applications for devices, imaging and sensing applications. We will discuss our recent efforts to make new functional polymers and materials that are designed to transmit, reflect, rotate or guide light across a wide optical spectrum to enable creation of new imaging and sensing platforms. We will discuss how these systems will improve human-machine interfaces and next generation sensors for transportation.

3:40-4:25 p.m. **Selective Proteomic Analysis of Cellular Sub-Populations in Complex Biological Systems**
Professor David A. Tirrell, Department of Chemistry, California Institute of Technology

This lecture will describe the use of non-canonical amino acids (ncAAs) as selective probes of protein synthesis in complex biological systems. Pulse-labeling with ncAA probes provides time-resolution, while controlled expression of mutant aminoacyl-tRNA synthetases allows the investigator to restrict analysis to cell types or cell states of interest. The methods are applicable to studies of microbial systems, mammalian cell culture, and a variety of animal models. The scope and limitations of the approach, and some of our most recent results, will be discussed.

4:30-5:15 p.m. **Macromolecular Engineering by Taming Free Radicals using Atom Transfer Radical Polymerization**
*Professor Krzysztof Matyjaszewski, **Nichols Medalist**, Center for Macromolecular Engineering, Carnegie Mellon University*

Macromolecular Engineering (ME) is a process comprising rational design of (co)polymers with specific architecture and functionality, followed by precise and efficient polymer synthesis and processing in order to prepare advanced materials with target properties. We employed radical polymerization for ME due to its tolerance to many functionalities although radicals are difficult to be controlled, since they have very short life times (<1 s) and are involved in side reactions. Taming free radicals was accomplished via dynamic equilibria between minute amounts of radicals and large pool of dormant species using Cu-based ATRP (atom transfer radical polymerization) catalytic systems. By applying new initiating/catalytic systems, Cu level in ATRP was reduced to a few ppm and ME provided polymers with precisely controlled molecular weights, low dispersities, designed architecture, organic-inorganic hybrid materials and bioconjugates. These materials are used as components of advanced materials for health and beauty products and for applications related to environment, energy and catalysis.

5:15 p.m. **Break**

6:00 p.m. **Medal Award Ceremony**

Presiding: Dr. Ruben M. Savizky, 2020 Past Chair, ACS New York Section

ACS Greetings: **Dr. H. N. Cheng**, President of ACS National
Dr. Thomas Connelly, ACS Chief Executive Officer;
Dr. Dorothy Phillips, Director at Large ACS Board of Directors
Dr. Katherine Lee, Director, District 1

Introductory Address: Professor David A. Tirrell, California Institute of Technology

Presentation of the Medal: Dr. Ruben M. Savizky

Acceptance Address: **Dr. Krzysztof Matyjaszewski**
Nichols Medalist

For More Information and to register (free): Please visit the New York Section website at www.NewYorkACS.org

DR. KRZYSZTOF MATYJASZEWSKI
2020 Nichols Medalist

Krzysztof (Kris) Matyjaszewski was born in Poland, in 1950. He obtained his PhD degree in 1976 at the Polish Academy of Sciences in Lodz, Poland, working with Prof. S. Penczek. Since 1985, he has been at Carnegie Mellon University (CMU) where he is currently J. C. Warner Professor of Natural Sciences and a director of Center for Macromolecular Engineering. He served as Head of Chemistry Department during 1994-1998. He also holds appointments of Adjunct Professor at the University of Pittsburgh, the Polish Academy of Sciences in Lodz and Technical University in Lodz, as well as Departments of Chemical Engineering and Materials Science at CMU.

Matyjaszewski's main research interests include controlled/living radical and ionic polymerization, catalysis and synthesis of advanced materials for optoelectronic, energy-related, environmentally-related as well as for biomedical applications. In 1994, he discovered Cu-mediated atom transfer radical polymerization (ATRP). In order to tame the uncontrolled free radical polymerization behavior, Matyjaszewski introduced a new concept to insert periods of ca. 1 min dormancy after each ca. 1 millisecond of radical activity. This way, the overall life of propagating chains was extended from about 1 second to several hours with hundreds of intermediate dormancy periods. This would be like extending person's life from 100 years to 3000 years, if after each 1 day of activity a person could be dormant for 1 month. The concept of equilibria between active and dormant species applies not only to polymer systems but also operates in biological systems, such as Vitamin B-12, and also redox equilibria in the respiratory chain and lipid isomerization or redox recycling of the antioxidant systems. ATRP has its roots in atom transfer radical addition/cyclization, a highly selective and efficient organic reaction. Organic chemists originally used very high concentration (ca. 10 mol %) of copper catalysts. Matyjaszewski invented new catalysts for ATRP, which are million times more powerful. This year he reported new ATRP catalysts, which are billion times more reactive than original catalysts used in seminal 1995 paper. Thus, they can be used at very low concentrations, parts per million (ppm) relative to monomer. The catalysts used in so small amounts can be continuously regenerated using mild reducing agents such as ascorbic acid, iron or copper wire, electrical current, mechanical forces or light under excellent spatio-temporal control. Now, organic chemists adopted these catalytic systems also to organic reactions.

ATRP has enabled preparation of well-defined, essentially tailor-made polymers via macromolecular engineering. In these systems, all polymer chains grow concurrently and steadily. This allows synthetic chemists to prepare a myriad of well-defined polymers, including block and gradient copolymers, stars, molecular brushes, also various bioconjugates by linking synthetic polymers with nucleic acids, proteins and enzymes, as well as inorganic-organic hybrids by anchoring polymers to nanoparticles, flat wafers and other inorganic materials. In 1996 and 2000, Matyjaszewski founded two industrial Consortia with over sixty participating international chemical companies to facilitate technology transfer to industry. So far, ATRP has been licensed 17 times and commercial production of advanced polymers by ATRP started in 2004 in US, Japan and Europe. ATRP has been used to prepare well-defined polymers with precisely designed and controlled macromolecular architecture, including various hybrids and bioconjugates, as well as smart, stimuli responsive systems. ATRP has been successfully used to commercially produce better pigment dispersants for inkjet printing, automotive and appliances coatings, cosmetics, chromatographic packings, adhesives, sealants for self-cleaning windows, flat panel display and automotive gaskets. Other applications, being evaluated, include drug and nucleic acid delivery, coatings for cardiovascular stents, scaffoldings for bone regeneration, biocidal surfaces, degradable plastics, and others in biomedical, optoelectronic, and automotive industry.

Matyjaszewski's group at CMU has comprised over 100 graduate students, 100 undergraduate students and over 140 postdoctoral fellows. He has co-authored over 1,100 publications (cited 160,000 times, h-index 193, Google Scholar), 100 book chapters, co-edited 24 books and holds 64 US and over 150 international patents.

Matyjaszewski received the 2021 Grand Prix de la Fondation de la Maison de la Chimie, 2017 Benjamin Franklin Medal in Chemistry, 2015 International Dreyfus Prize in Chemistry, 2014 National Institute of Materials Science (Japan) Award, 2012 Maria Curie Medal, 2012 Dannie-Heineman Prize, Goettingen Academy of Science, 2011 Wolf Prize in Chemistry, 2009 Presidential Green Chemistry Challenge Award, and from the American Chemical Society: 2020 Paul Flory Polymer Education Award, 2019 Award in Chemistry of Materials, 2013 AkzoNobel North America Science Award, 2011 Hermann Mark Award, 2011 Award in Applied Polymer Science, 2002 Polymer Chemistry Award, 1995 Creative Polymer Chemistry Award. He received eleven honorary degrees (Ghent, Lodz, Athens, Moscow, Toulouse, Pusan, Paris, Technion, Poznan, Padova, Coimbra) and is a member of National Academy of Engineering, National Academy of Sciences, Polish Academy of Sciences, Russian Academy of Sciences, Australian Academy of Sciences, European Academy of Sciences, honorary member of Israel and Chinese Chemical and a fellow of National Academy of Inventors, International Union of Pure and Applied Chemistry, and American Chemical Society.

THE WILLIAM H. NICHOLS MEDAL AWARD

Dr. William H. Nichols, a charter member of the American Chemical Society and its president in 1918 and 1919, was a pioneer in the development of the chemical industry in the United States and an early champion of the importance of chemistry in the future growth of the nation. The success of his companies can be traced to several notable principles that guided Dr. Nichols' career. First was his deep belief in research and development. Second was his support for science education and the students of chemistry. Third was his concern for the welfare of his employees. Overriding all of these was his often quoted belief that "the Golden Rule is as applicable in business as it is in church". It is this legacy of Dr. William H. Nichols that the New York Section is proud to maintain in its annual award of the Nichols Medal each spring.

It was in 1902, that Dr. Nichols established this annual award, the first in its field, of a gold medal to be presented to a chemical scientist for original research. The William H. Nichols Medal was first awarded in 1903. Since its inception, the New York Section of the American Chemical Society has administered the award. It has been perpetuated through the generosity of Dr. Nichols, his family, and the Nichols Foundation, Inc. The award ceremony has evolved into a Distinguished Symposium and a Medal Award Banquet during which scientists can interact with their colleagues and with chemistry students. The Nichols Medal itself depicts the allegorical figure of Dr. Faust in his laboratory as described by Goethe, and the obverse side bears an inscription of the name of the medalist and the award citation. A listing of all of the William H. Nichols Medalists and their medal citations can be found at www.newyorkacs.org/nicholsmedalists.html.

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