Professor Krzysztof Matyjaszewski
2020 William H. 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 100,000 times, h-index 154, ISI), co-edited 20 books, 99 book chapter and holds 62 US and over 150 international patents.

Matyjaszewski received 2017 Benjamin Franklin Medal in Chemistry, 2015 International Dreyfus Prize in Chemistry, 2014 National Institute of Materials Science (Japan) Award, 2013 Madison Marshall Award, 2012 Prize of Société Chimique de France, 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: 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, honorary member of Israel and Chinese Chemical Society and a fellow of National Academy of Inventors, International Union of Pure and Applied Chemistry, and American Chemical Society.