DIVISION OF POLYMERIC MATERIALS: SCIENCE & ENGINEERING

Cooperative Research Award in Polymer Science and Engineering

Sponsored by the Eastman Kodak Company

2010 Award Winners

Nikos Hadjichristidis

University of Athens

David J. Lohse

ExxonMobil Research and Engineering

The 2010 winners of the Cooperative Research Award in Polymer Science and Engineering presented by the American Chemical Society's (ACS) Division of Polymeric Materials: Science and Engineering (PMSE) are Professor Nikos Hadjichristidis, University of Athens and Dr. David J. Lohse, ExxonMobil Research & Engineering Co. Professor Kurt Wiegel, Chair of the PMSE Cooperative Research Award Committee, announced the award, which is endowed by the Eastman Kodak Company and has been presented annually since 1992.

Prof. Hadjichristidis and Dr. Lohse have worked together for over 20 years in many areas of polymer science, including the synthesis of model long chain branched polymers and their rheology, the synthesis and morphology of miktoarm polymers, and polymer blend thermodynamics. All of this work is characterized not only by a strong academic/industrial partnership, but also a highly interactive collaboration between the devising the chemistry needed to make novel polymeric architectures and the discovery of the new physics exhibited by these materials. This research is thus cooperative in several senses: it combines academic interest in the science of polymers with the technological needs of the marketplace; it joins the synthesis of precisely controlled molecules with a careful analysis of their basic physical properties; and it represents a strong international collaboration. This work has chiefly been focused on three areas:

Long Chain Branching: It is well known that long chain branching (LCB) has a strong effect on the rheology and properties of polyethylene, but detailed molecular level understanding of the effect of architecture on these physical properties has been lacking. The awardees showed how the details of LCB architecture impact processing and performance. This involved the precise techniques of anionic polymerization to make a wide variety of polydienes with well-defined structures, including linear, star, comb, pom-pom, and dendritic topologies, followed by saturation to make the corresponding model polyolefins. Next, they studied the physical properties of these model polymers, especially their rheology, to establish the fundamental structure-property relations for them. For example, they showed that, while all forms of LCB dramatically affect shear rheology, only chains with multiple branch points, such as combs, produce extensional thickening. In turn, extensional rheology controls bubble stability in film blowing operations. Besides yielding 19 papers and 3 patents, this work has directly impacted the development of new easier processing polyolefins by ExxonMobil.

Block Copolymer Morphology: One of the great successes of polymer science has been the development of block copolymers that exhibit microphase separation into well-ordered, nanometer-scale domains. These materials show unique properties that have been exploited in many applications. However, for linear block copolymers, the basic morphology of the domains (spheres, cylinders, lamellae, bi-continuous) is strongly determined by the percentage of each block. So by using linear block polymers, it is not possible to significantly vary the volume fractions where a given type of morphology can be found. The work of the awardees has shown that this restriction can be overcome by using non-linear block polymers. These are the so called "miktoarm" star copolymers, where the arms of the star are made from two (or more) chemically different species (such as polystyrene and polyisoprene). They first developed robust ways to synthesize such "miktoarm" polymers and discovered that the rigid relationships between morphology and volume fraction, shown by linear block polymers, do not apply for "miktoarms". They showed how the morphology depends on the relative numbers of arms of each component, as well as the intrinsic stiffness of each chain. Such results open up the possibilities for many new applications, such as membranes with highly controlled pore sizes.

Polymer Blend Thermodynamics: A significant fraction (> 30%) of polyolefins is used as blends, but it has been difficult to predict which polyolefins will mix and which will not. The awardees have shown how the chemical structure of these polymers controls their miscibility. In particular, the ability to predict how various polyolefins mix with each other has aided in the development of several new products from ExxonMobil Chemical Company. This work has also had a great influence on the direction of polymer blend science, as evidenced by over 1000 citations to this body of work.

David J. Lohse received B.S. degrees in both Physics and Computer Science from Michigan State University in 1974, and a Ph. D. in Materials Science from the University of Illinois in 1978. He then spent two years at the National Bureau of Standards in Gaithersburg, MD under an NSF-NRC Fellowship, working on the theory of polymer solutions with Isaac Sanchez. Since then he has worked for Exxon Mobil Corporation, first in the Long Range Polymer Research Group of Exxon Chemical Co., and since 1987 in what are now the Corporate Strategic Research Labs of ExxonMobil Research & Engineering Co. in Annandale, NJ. There he currently holds the position of Distinguished Research Associate, and his work focuses on the thermodynamics of mixing polymer blends, nanocomposites, neutron scattering from polymers, the control of rheology by molecular architecture, polymer crystallization, the use of block and graft copolymers to enhance blend compatibility, and the application of such knowledge to develop improved polymer products. His research has resulted in over 110 publications (including a book on "Polymeric Compatibilizers" written in 1996 with Sudhin Datta of ExxonMobil Chemical Co.) and 30 US patents. He has also served the Polymeric Materials: Science and Engineering (PMSE) division of the American Chemical Society in several capacities. Among these are Program Chair from 1991-94, Secretary in 1995, Chair in 1998, and chair of the Fellows Committee from 1999-2003. Since 2003 he has been a Councilor for PMSE. He was elected a Fellow of the American Physical Society in 2000 and a PMSE Fellow in 2005. In April 2008 he received the Distinguished Service Award from PMSE.

Nikos Hadjichristidis obtained his BSc at the University of Athens, Greece, in 1966, his PhD at the University of Liege, Belgium in 1971, and his DSc at the University of Athens, Greece, in 1978. He conducted postdoctoral research at the University of Liege (1971–1972) and at the National Research Council of Canada (1972–1973). In 1973 he became a lecturer at the University of Athens, Department of Chemistry, followed by promotions to Assistant Professor (1982), Associate Professor (1985) and Full Professor (1988). He has been the Director of the Industrial Chemistry Laboratory at the University of Athens since 1994 and the Chairman of the Chemistry Department (1991–1995, 1999-2003 and 2005-2009). He has supervised 45 Ph.D. and 55 Masters' theses.

Prof. Hadjichristidis was a Visiting Scientist at the University of Liege (Summers 1974, 1975); Visiting Research officer at the NRC of Canada (Summer 1976), Visiting Scientist at the University of Akron (Summers 1977 through 1982) and a Distinguished Visiting Scientist at the NRC of Canada (1983). He has been a Visiting Professor at Exxon Research and Engineering Co, NJ since 1984, where he spends 1–2 months every year. He was also an Invited Professor in the graduate courses in Polymer Chemistry at the Royal Institute of Technology in Stockholm (2003) and the Technical University of Denmark in Copenhagen (2004 and 2006), as well as at the PLAPIQUI (Institute of Chemical Engineering of the National Research Council of Argentina), Bahia Blanca, Argentina (2004) and the Simon Bolivar University (Department of Material Science), Caracas, Venezuela (2005). He has given numerous plenary lectures at International Symposia, as well as invited seminars at Universities, Institutes and Industries worldwide. He has served as the President of the European Polymer Federation (1995–1996), as a Member of the National Advisory Research Council (1994-2007), as the President of the State Highest Chemical Board (1995-2005), and was the Director of the Institute of "Organic and Pharmaceutical Chemistry" of the National Hellenic Research Foundation (2000-2001). He received the Academy of Athens Award for Chemistry (1989), the Empirikion Award for Sciences (1994), the Greek Chemists Association Award (2000), the ACS PMSE A. K. Doolittle Award (2003) and the International Award of the Society of Polymer Science, Japan (SPSJ, 2007). He was elected as a PMSE Fellow for 2004 and was the "Ralph Milkovich" Memorial Lecturer for 2006 at the University of Akron. He was also a Member of the Editorial Board of "Macromolecules" (1997-1999), and is currently an Editorial Board Member of "Journal of Polymer Science, Polymer Chemistry" (since 2001), "Progress in Polymer Science" (since 2001) and is Editor of "European Polymer Journal" (since 2002). He has dedicated his career primarily to the synthesis of model polymers and has published 365 papers and 23 reviews in referred scientific journals (citations until 15th of October 2009: 10200, h-index: 54, Web of Science), 6 patents, two books (editor), and is the author of one book on Block Copolymers (Wiley 2003).

The award, which includes a $5,000.00 prize, will be presented at PMSE's awards reception and will be recognized by the Symposium "Cooperative Research Award Symposium in Honor of David Lohse and Nikos Hadjichristidis" at the 239th American Chemical Society meeting in San Francisco, California (March 2010).