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Future Trends in Polymer Science A Symposium in Honour of the 100th Birthday of Herman F. Mark

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A Symposium in Honour of the 100th Birthday of Professor Herman F. Mark was held on May 3, 1995 in the Polymer Research Institute† at the Brooklyn Polytechnic University at New York, USA. Although Herman Mark never won Nobile Prize, for a long time world scientific community considered him as the Leader (God Father) of Polymer Science.‡

Dr. Mark was born in Vienna on May 3, 1895. After service in World War I, he studied at the University of Vienna, obtained his Ph.D. with Dr. Wilhelm Schlenk, summa cum laude in 1921 and moved as instructor to the University of Berlin. One year later he joined the Kaiser Wilhelm Institut fuer Faserstoff-Chemie in Dahlem where he worked first as Research Fellow and later Group Leader until 1926. In 1927 he joined the I. G. Farben at Ludwigschaffen as Research Chemist, became Group Leader in 1928, and assistant Research Director in 1930. In 1932, he was appointed Director of the first Chemical Institute at the University of Vienna. After the invasion of Nazis in 1938, he went to Canada and became Research Director of the International Paper Company. In 1940 he joined the faculty of the Polytechnic Institute as Professor of Chemistry and became the Director of the Polymer Research Institute in 1946. Dr. Mark maintained an active schedule as world traveler and lecturer. However, his home base remained at the Polytechnic University where he was Dean Emeritus and an emeritus member of the Board of Trustees.

Dr. Mark had led an eminent industrial research team in creating many commercial polymers and established a famous Polymer Research Institute. His principal research was on X-rays and electrons for the study of the structure of matter, and on the synthesis, characterisation, reactions, and properties of natural and synthetic polymers. His contributions include clarification of basic principles, encouragement of academic-industrial interactions, and the founding of the Journal of Polymer Science,

† Professor H. F. Mark was the Founder of the Polymer Research Institute.

‡ This fact was also recognised by Nobile Prize Winners, Paul Flory and Michael Schwarz.

the definitive publication in the field, the *Journal of Applied Polymer Science*, and the *Encyclopedia of Polymer Science and Technology*.

Dr. Mark was acknowledged throughout the scientific community as a founding father of polymer science. He received the National Medal of Science in 1980, the 1978 Senior U.S. Scientist Award, over 30 other medals and awards from various international organisations, and 17 honorary degrees. He published over 500 original and review articles and some 20 books on topics related to polymer science.

Dr. Mark has earned a lasting place in the history of polymer science through his research contribution, the successes of his students, his organisation genius, and his tireless promotion of polymer science. It is entirely accurate to say that Dr. Herman Mark found polymers a curiosity and them a science. Dr. Mark died on April 6, 1992. Subsequently, the Polymer Research Institute was renamed the Herman F. Mark Polymer Research Institute.

About 150 scientists from USA, Canada, Israel, Russia, Italy, China, Korea and other countries participated in the Symposium. The title of the symposium ('Future Trends in Polymer Science') defined the topics of 10 plenary lectures. The symposium was open with remarks of the present Director of the Polymer Research Institute, Professor Eli M. Pearce who talked about the contribution of Professor Mark in the science. The brief historical review of the life of Herman Mark was given by his son, Professor of the University of Texas at Austin Hans Mark, Advisor of the US Government at Reagan Administration. Then participants of the symposium got an opportunity to watch Herman F. Mark Video.

The first plenary lecture was given by Professor Norbert M. Bikales (National Science Foundation) who talked about trends in Federal Funding for Polymer Science. Other 9 lectures followed a plan: "The contribution of Professor Herman Mark in the development of different areas of Chemistry and Physics of Polymers." Professor Otto Vogl focused upon macromolecular architecture for the future. Professor Paolo Corradini (Federico University of Naples, Italy), the disciple of Giulio Natta reviewed results and perspectives of new stereoregular polymers and polymerisation processes. The lecture of Professor David A. Tirrell§ (University of Massachusetts at Amherst) related to the synthesis of polymers on messenger RNA templates. The problems of how to do the self-assembled monolayers click were discussed in the lecture of Professor Abraham Ulman (Brooklyn Polytechnic University). Professor Eric Baer (Case Western Reserve University) considered hierarchical structures in natural and synthetic polymer science. The final communications of Professor Ronald K. Eby from the University of Akron ("Lessons from Biology: Structure and Properties of Spider Silk"), Professor Joseph M. DeSimone from the University of North Carolina at Chapel Hill ("Polymer Synthesis and Processing in Carbon Dioxide"), Professor Anna C. Balazs from the University of Pittsburgh ("Designing Interfacially Active Copolymers Through Computer Simulations") and of Professor Samuel L. Stupp from the University of Illinois at Urbana-Champaign ("Molecular Object Polymers and Materials for the Future") were also of great interest.

In his concluding remarks Professor Eli Pearce focused again on those ideas of Professor Herman Mark which were successfully developed by his disciples and other scientists over the world.

§ Professors Tirrell and Pearce are Editors-in-Chief of the *Journal of Macromolecular Science*.

OVERVIEW OF RESEARCH ACTIVITIES of the Herman F. Mark Polymer Research Institute at the Brooklyn Polytechnic University

The Polymer Research Institute (PRI) at the Polytechnic University was founded by Herman F. Mark soon after he joined the Polytechnic in 1942. The present director of PRI is Eli M. Pearce. Polymer research at the Polytechnic is currently funded by government and industry at over \$2,000,000.

The Polymer Research Institute has a commitment to interdisciplinary research activities involving several Polytechnic departments. Such interdisciplinary efforts both in research and teaching emphasise an integrated approach; namely, synthesis, characterisation, structure, processing, properties, and applications of polymers. There are presently over 25 faculties associated with PRI, a number with prior industrial experience.

GENERAL FOCUS

The Polymer Research Institute (a) coordinates multidisciplinary polymer research activity; (b) seeks out and nurtures interactions and opportunities for groups and individuals at the Polytechnic to participate in joint research activities; (c) serves as a nucleus for short courses, seminars, and symposia; (d) seeks expanded interaction with the industrial community and works with research centres at the Polytechnic and/or other institutions. Within this context, all areas of polymer science, engineering and technology have been PRI's focus and include making, developing and evaluating polymers used in biomedicine, biotechnology, electronics, telecommunications, transportation, highways, etc.

PRESENT DIRECTIONS

Research areas of interest of PRI include biopolymers, conductive polymers, dielectric behaviour of polymers, interfaces in polymeric systems, high temperature polymers, molecular modelling, polymer blends and composites, polymer degradation and stabilisation, membranes, polymer gels, flammability, polymer-microwave interactions, polymer photoresists, polymer processing, polymers in glassy state recycling, scattering of light and neutrons in polymers and stereochemistry.

SELECTED PROJECTS AND ACTIVITIES

Composite Materials

Current research on composites is aimed primarily at understanding, controlling, and optimising these materials. There are studies underway on: (1) fundamental model-

ling of existing processes; (2) novel processing techniques using microwave energy, and (3) development of sensors capable of in-situ monitoring of chemical and physical changes in real-time. Such sensors form the basis of the so-called "smart" structures, an area of considerable interest to interest.

Polymer Blends

The combination of older, well established polymers to form blends or "alloys" which possess outstanding performance and properties has been PRI's focus. Work is in progress on the use of polymer blends also in separation technology, including controlled release of chemicals. These activities have led to new approaches to design "molecular composites."

Complex Polymer Fluids

The objective of this programme is to quantify the equilibrium and non-equilibrium properties of multicomponent polymer mixtures. The emphasis is on complex polymer fluids in which one or more of the constituent polymer species self-assemble into specific microstructures. The response of these systems to changes in external conditions, like temperature, pressure or stress is strongly dependent on the response of the microstructure to these changes.

Molecular Modelling of Polymeric Materials

PRI is interested in the prediction of bulk properties of materials by using computer simulation and theories that rely on a detailed molecular description of the material.

Biopolymers

Polysaccharide structure-function relationships and biomedical applications are under active study. These studies led to new methods to monitor disease states and therapies, better understanding of the natural roles of polysaccharides, and new biopolymeric products for medical applications.

Ageing, Stabilisation, and Flammability

Extensive programmes are underway to understand how to stabilise and control the degradation of polymers for environmental control and disposal, and to stabilise certain polymers so that they can be recycled and reused.

Polymer flammability, the degradation of polymers at high temperature to give combustible volatiles, is under intense study by using new condensed phase reactions to decrease the volatiles formation. Many of these programmes are sponsored by industry.

Synthesis and Evaluation of Functionalised Polymers

PRI designs polymers by synthesising new structures or modifying known polymers to behave in a desired manner so that they have specific functions and can be "smart." Typical problems are associated with new systems which are electronic

and photonic active, membranes with unique temperature and pH sensitivity for separations, chiral and liquid crystal phenomena, drug delivery concepts, and improvements in dimensional stability.

Electrical and Optical Properties of Polymers

Current research also include synthesis and characterisation of electron and alkaline ion conducting polymers. The applications of these new polymers are being investigated for electrodes and electrolytes in ambient temperature rechargeable alkaline batteries and also in electrochromic devices.

Plasma Polymerisation

Current investigations on the diffusion of small molecules in fluorine containing plasma polymers and developing methods to modify the properties of plasma polymers by incorporating, during the polymerisation, certain molecules into the plasma polymer matrix to modify electrical properties.

PARTICIPATION

The 25 principal investigators doing polymer research come from the Chemistry, Chemical Engineering and Materials Science Departments or are directly attached to the PRI. About 35% of PRI's research is industry sponsored, and 50% is government sponsored. Over \$2 million of research is currently underway, many of PRI's faculties have been associated with industrial research. Currently programmes are also Brookhaven National Laboratory and other local universities.

FACILITIES

PRI is well equipped with all types of polymer characterisation tools. These include a new state-of-the-art facility in thermal analysis (The Professor Edith A. Turi Thermal Analysis Laboratory), 300 megahertz NMR with solid state capabilities, Fourier transform infra-red and other spectroscopic tools including ESCA, and various instruments for microscopy (TEM/SEM/STEM).

Therefore the Polymer Research Institute met the jubilee of his Founder full of creative forces and new ideas in the area of Chemistry and Physics of Polymers.