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POLYMER SCIENCE AND TECHNOLOGY

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NEW MONOMERS AND POLYMERS

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PREFACE

Interest in preparing new polymers peaked about 1966. Since that time, industrial and government support for the synthesis and study of new polymers has steadily declined. Gone are the good days when government funds supported a great push to attain ultimate thermal stability for organic polymeric materials. Gone are the good days when many chemical companies, encouraged by the obvious potential for rewards, had great interest and provided support for preparing new polymers. We now often hear managers say "we have enough polymers" or "all we need to do is find additional and better ways to use existing polymers." The latter often includes the statement, "we can get the new materials that are wanted from polymer alloys or blends."

Interest in preparing new monomers has also waned, even though it is well recognized that monomers with special functionality are greatly needed to fine-tune existing polymers for specific tasks.

Shrinkage of interest in new monomer and polymer research has not come about solely as a result of the obvious maturity of the polymers industry. Since uses for polymers continue to grow and there is still room for good concepts to study, lack of market growth and fields of study have probably not significantly contributed to that shrinkage. For the most part, loss of interest has come about due to the high cost of coming up with a totally new polymer and then doing all that is needed to market the new materials. Preoccupation with raw materials cost, market size, energy needs, and health and environmental concerns has also contributed to support shrinkage, especially for discovery and introduction of new monomers. However, management should keep in mind the rapid development and commercialization of a variety of new water-soluble coating polymers which followed the government's imposition of solvent emission standards in the late 1970's. A motivated management will find that a tremendous potential for synthetic development still exists.

A report (1981) entitled "Polymer Science and Engineering: Challenges, Needs, and Opportunities," issued by the National

remarked "I am inclined to think that the development of polymerization is perhaps the biggest thing chemistry has done, where it has had the biggest effect on everyday life. The world would be a totally different place without artificial fibers, plastics, elastomers, etc. Even in the field of electronics, what would you do without insulation, and there you come back to polymers again." Thinking about Lord Todd's remarks, one could add that the story is far from finished. Polymeric materials, as they are constantly being modified and improved, fine-tuned for current and additional needs, and more readily accepted by the public, will have an ever expanding influence on everyday life. However, lack of long-term support of meaningful size for basic research on all facets of polymer chemistry and engineering could well stunt the growth of high technology in our country and help insure that we won't have materials with performance profiles to meet requirements of emerging technologies and national needs. For example, in the high-tech microelectronics area, many opportunities exist for polymers to serve as improved dielectrics, improved plasma etch resistance barriers, improved lithographic resists, etc., where, simultaneously, many other properties such as adhesion to a variety of inorganic substances, water permeability, and temperature stability must not be limiting. Polymers for biomedical applications, likewise, provide a rich opportunity for synthetic innovation.

In consideration of the above and to foster more interest in new monomers and new polymers, a symposium was scheduled for the Kansas City meeting, titled "New Monomers and Polymers." At the same time, it was recognized that such a symposium would help meet the need and interest of many members of the ACS's Division of Polymer Chemistry. It is well known that many members of the Division have great interest in polymer synthesis and desire timely symposia to present and discuss their studies.

The Kansas City symposium on New Monomers and Polymers consisted of twenty-six papers, reasonably representative of the current interest in, direction of, and opportunities for research on new monomers and polymers. The papers clearly showed that great opportunities exist for new work in both step-growth and chain-growth polymerization and in the introduction of new monomers. For a variety of reasons, not all the papers from that symposium are included in this book, even though each author was invited to contribute. However, additional papers were solicited and/or accepted to broaden the scope of the book and give readers a better picture of the many opportunities and challenges that exist for preparing new monomers and polymers.

Although all the chapters in this book cannot be neatly categorized, except as representative of either step-growth or chain-growth polymerization studies, the subject matter falls into one

Research Council's ad hoc Panel on Polymer Science and Engineering, clearly recognized the need and urgency of increased commitment to basic studies on polymers. The Panel's list of needs and opportunities included challenges for basic/applied research on monomers, polymerization methods, specialty polymers, high-performance materials, and in situ polymerization methods for direct conversion of monomers to useful shapes. Clearly, as substantiated by the NRC report, industry and government must not neglect support of basic research on polymers. Further, a significant part of this support should be directed to new monomers and polymers.

At the fall 1982 National Meeting of the American Chemical Society in Kansas City, a special Polymer Education Award Honoring Herman F. Mark was presented. It was followed by a panel discussion concerning the state of polymer education at U.S. universities. While the award to Professor Mark was, indeed, a joyous event, the discussion that followed was sobering. Speaker after speaker pointed out a serious decline in the position of polymer chemistry within the chemistry departments of U.S. universities. It is true that several interdisciplinary polymer programs or institutes exist, but there is an increasing dominance by engineering and materials science aspects. Within chemistry departments the position of polymer chemistry, which has always been tenuous at best, was thought to be declining. We were told that it was unlikely that polymer chemists such as P.J. Flory (Stanford), W. Bailey (Maryland), and C. Marvel (Arizona) will be replaced by polymer chemists. Perhaps the most depressing aspect of this situation is that it will affect synthetic polymer chemistry most seriously because it is most difficult to develop and conduct innovative frontier syntheses outside a chemistry department where other strong synthetic programs already exist. Students who want to become synthetic chemists will seldom enroll in a program outside a chemistry department.

The discussion pointed out that very few of the "top twenty" chemistry departments have a polymer chemist (much less a synthetic polymer chemist) on their faculties, and there appear to be no plans to change this situation. The number of synthetic polymer chemists in the "top eighty" chemistry departments is also not growing and may be declining. There seems to be a reluctance within traditional chemistry departments to recognize and promote the elegance in synthetic methodology (organic, inorganic, biochemical, organometallic) which exists within the field of macromolecules. We all realize that several reasons exist for this prejudice and that many of these are less noble than many chemists care to admit. It appears that we could learn profitable lessons from the Japanese, who have placed a higher value on synthetic polymer chemistry within their "ivied halls."

Lord Todd, President of the Royal Society of London, recently

or more of the following categories:

- High-Performance Polymers
- Aromatic Heterocyclic Monomers
- Thermally Stable Polymers
- High-Performance Composites
- Reactive Oligomers
- Aromatic Polyformals
- Star and Comb Shape Copolymers
- Polymers in Phase Transfer Catalysis
- Organometallic Polymers
- Polymers in Medical Applications
- Nitrogen-Containing Polymers
- Vinyl Organometallic Monomers
- Functionalized Polymers
- Anionic Copolymerizations
- Macromers
- Functional Methacrylate Polymers
- Block Copolymers
- Ring Opening Polymerizations
- Cationic Polymerizations
- Polymers Containing Transition Metals
- Conductive Polymers
- Diyne Polymers
- Ziegler-Natta Polymerizations
- Quinodimethane Polymers
- Charge-Transfer Copolymerizations
- Reactions on Polymers
- Polymeric Dyes
- p-Methylstyrene Monomers and Polymers

The work discussed in the various chapters clearly shows that great opportunities exist for research and development on new monomers and polymers. In addition, the work done at Mobil on poly(p-methylstyrene) decisively illustrates that great opportunities still exist for finding routes to new monomers that need not be tied to small specialty markets. After all, in a few years p-methylstyrene could become a fairly high volume commodity chemical and its homopolymer and copolymers could make a very large market impact (W.W. Kaeding, L.B. Young, and A.G. Propas, Chemtech, 556-562, September, 1982).

Bill M. Culbertson
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