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New Horizons in Environment and Application of Polymeric Materials

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“Devastating wars will always take place on Earth bringing death and destruction of the planet’s forests with infinite spite and then focus their rage on every living thing to be found around, bringing pain and damage, sufferings and death. The wind will blow plantless ground all over the world and cover the remnants of creatures that once made different countries alive and pleasant.” So prophesied Leonardo da Vinci. The tragic bombing of Hiroshima and Nagasaki seem to show that nobody can win or lose a nuclear war, and the “Peaceful Nuclear Technology” of Chernobyl Nuclear Station only support this conclusion. But mankind also face another catastrophe, the ecological one. What is the outlook regarding pollution of atmosphere, water and soil for the next 20–25 years? The long-term prediction is always difficult to guarantee the outcome of all programs on the improvements of the fuel balance, modernisation of older plants, the development of novel technologies and new polymers and composites (less toxic, which may be reused or destroyed using the products of degradation or heat). Following two versions of prognosis the release of sulphur dioxide will be reduced by 11–12% in 1980–2030, but the third version predicts a 9%-increase (Proceedings of Conference of Chemrawn-Chemical Research Applied to World Needs, IUPAC, Oxford, 1990). This difference could be explained by the fact that some predictions are based on the activity of older plants. More accurate prognosis on the production of polymers was given in the 208-th National Conference of the American Chemical Society, which was held in Washington, DC on August 21–25, 1994. The current production of synthetic polymers, as well as natural polymers (cellulose and its derivatives, natural rubber, etc.) have each been estimated at 130 million tons per year. This gives 250–260 million tons in aggregate, and, if we convert this quantity into the volume, we get 240 million cubic meters per year. We can compare this figure with an annual production of 100 million cubic meters of steel and 14 million cubic meters of other metals (copper, aluminium, zinc, cobalt, etc.). Therefore, the production of polymers is greater than of all metals together. The dynamics of the development of production is also important. The volume of production of polymers is expected to increase two-fold from 1995 to 2010. For the same period we will get only 1.5 times more metals.

This huge production creates the problem of recycling of polymeric materials. Presently the main part of polymeric waste is collected and burned, in rubbish heaps, although there are special plants for burning polymers in Western Europe, Japan and the USA. The barbaric way of destroying polymers by fire in rubbish heaps is described by J. Barton, who wrote: "There are two possibilities—either mankind makes less smoke to be on Earth or the smoke makes less men to live." According to Jacques Ives Cousteau, "Our globe resembles a car, running alone in the space with exhaust pipe revealed into the passengers' saloon. The more force we apply to the accelerator, the higher the probability is to poison the driver and the passengers."

Pollution also poses economical problems. Since the price of raw materials for polymers can only increase, ways of polymer reutilisation are required, such as polymer recycling and decomposition to monomers. The purified monomers can be further polymerised, and the rest can be destroyed by fungi and bacteria without damage to the environment.

Now the attention of scientists and engineers is focused upon the development and application of ecologically friendly polymers. These are biodegradable polymers and polymers which can be thermally degraded and even burned without producing toxic volatiles such as dioxine, hydrogen chloride, etc.

Here we describe one conference which tried to answer some of the above questions.

The Conference on Horizons for Environmentally Conscious Polymer Engineering was held on May 17–19, 1995 in the University of Connecticut at Storrs, USA. This meeting was sponsored by the Army Research Office, the State of Connecticut, Critical Technologies Program, and the Polymer Science Program of the Institute of Materials Science, University of Connecticut through its NSF Traineeship Program on Environmental Aspects of Polymer Recycling. The Symposium was personally organised by two famous experts in the area of Chemistry and Physics of Polymers, Professors of the University of Connecticut Samuel J. Huang and Jeffry T. Koberstein. The Conference was aimed to summarize state-of-the-art methods of environmentally-sound reutilisation, application and disposal of polymers, and to define the associated challenges and opportunities for the next decade.

The keynote lectures were given by Professors Huang and Koberstein who over-viewed the environmental aspects of polymer engineering. Some 150 scientists from USA, Germany, Japan, Russia, Canada, China and Korea participated in the symposium representing 70 research centers of universities, academic institutions and industrial companies.

Invited lectures were given by Professor Y. Doi from the Institute of Physical and Chemical Research, Japan ("Research and Development of Biodegradable Polymers and Plastics in Japan"), Professor K. F. Ziegahn from Fraunhofer Institute, Germany ("From Gradle to Grave-Closed Loop Material Management by Reuse and Recovery of Polymers: European and German Perspectives, Policies and Legislative Trends"), Dr. T. S. Ellis from "General Motors," USA ("Recycling Alloys and Mixtures of Thermoplastics from Automotive Scrap"), Dr. G. Swift from "Rohm and Haas," USA ("Water-Soluble Biodegradable Polymers"), Professor G. E. Zaikov from the Institute of Biochemical Physics of the Russian Academy of Science at Moscow ("New Types of Ecologically Safe Flame Retardants"), Dr. D. Kaplan from the US

Army Research, Development and Engineering Center at Natick ("Biotechnological Approaches to Environmental Issues in Materials"), Dr. I. Wadehra from IBM, USA ("IBM Initiatives in the Designing of Environmentally Conscious Information Technology Equipment"), Dr. I. Noda from "Procter and Gamble," USA ("Solid Waste Disposal Considerations for Environmentally Responsible Materials"), Dr. R. W. Lenz from the University of Massachusetts at Amherst, USA ("Bacterial Production of Environmentally Friendly Polymers") and Dr. S. L. Suib from the University of Connecticut at Storrs ("Catalytic Decomposition of Halogenated Hydrocarbons").

The final session of the Symposium was left for the Panel Discussion with participation of Professors Y. Doi, G. E. Zaikov and K. F. Ziegahn, and Dr. R. Reeber (US Army Research Office), N. M. Bikales NSF, USA), M. Bitritto (Hoechst Celanese, USA) and S. S. Labana (Ford Motor Company, USA). Unfortunately, the discussion mainly focused not on scientific problems, but on technological and financial aspects as well as legislative trends in the environmental area. Nevertheless, some perspectives of the application of biodegradable polymers also received a little discussion.

The consideration of the biotechnological aspect of the production of polymeric materials was undoubtedly success of the Conference, since the bacterial or fungal production of polymers was now the most progressive way to get environmentally friendly materials.

The next conference of this kind is planned for 1997.