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Biodegradable Plastics and Polymers

Proceedings of the Third International Scientific Workshop on Biodegradable
Plastics and Polymers, Osaka, Japan, November 9–11, 1993

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Foreword

It was a great pleasure for us to receive nearly 300 researchers, scientists and engineers from all over the world at the Third International Scientific Workshop on Biodegradable Plastics held in Osaka, Japan, in November 1993.

Twenty-three oral presentations by invited speakers and 50 poster presentations by researchers who responded to our call, enabled us to learn new research results and developments in the field of biodegradable plastics and polymers. We enjoyed lively and fruitful discussions and had rewarding exchanges of information through the three days of formal sessions and at the reception.

In publishing the proceedings of the workshop, we wish to express our heartfelt thanks to the invited speakers and the participants in the poster session for their kind cooperation. At the same time, we wish to express our deep appreciation to all who participated in the workshop.

The next, fourth workshop is scheduled to be held in the autumn of 1995 in Boston, U.S.A. We sincerely hope all of you will be able to attend the fourth workshop and learn the latest scientific and technical achievements. We also hope to see many biodegradable plastic products on the market by that time.



Kishimoto, Yasunobu
Chairperson of the Workshop

Preface

In the last quarter of this century, plastic products have gained universal use not only in food, clothing and shelter, but in the transportation, construction, medical and leisure industries as well. Synthetic plastics were developed as durable substitute product. Recently, there is a growing demand for biodegradable plastics as a solution to problems concerning the global environment and the solid waste management. The research on biodegradable plastics and polymers has been carried out worldwide with the aim of achieving a harmony between human activities and natural environment.

Against this background, The Third International Scientific Workshop on Biodegradable Plastics and Polymers was held at the Senri Life Science Center in Osaka, Japan, from November 9 to 11, 1993, following the past two workshops in Toronto in November 1989, and in Montpellier in November 1991. Based on the decision at the second workshop in Montpellier that the next workshop should be organized in Japan, Biodegradable Plastics Society of Japan undertook to host the third workshop.

Biodegradable Plastics Society was established in 1989 for the purpose of promoting the development and commercialization of biodegradable plastics technology. The Society has been engaged in drafting of "Definition of Biodegradable Plastics" and "Test Methods of Biodegradability" while conducting field tests of biodegradable plastics. The interim results were presented at the third workshop.

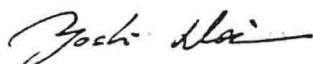
Besides, the Society has not only held many symposia in Japan including "The International Symposium on Biodegradable Plastics" in Tokyo in 1990 (ISBP90) but also sent its representatives to many international symposia and institutes for exchange of opinion and information in this field.

The Third International Scientific Workshop on Biodegradable Plastics and Polymers was supported by six Japanese government agencies--Ministry of International Trade and Industry; Ministry of Agriculture, Forestry, and Fisheries; Ministry of Health and Welfare; Ministry of Education, Science and Culture; Environment Agency; and Science and Technology Agency--and by Japan Bioindustry Association.

The main topics of the third workshop were as follows:

1. Biodegradation of polymers and plastics
2. Environmental degradation of plastics
3. Synthesis and properties of new biodegradable plastic materials
4. Biodegradation and morphologies of polymer blends
5. Development of biodegradation test method
6. Governmental policy, regulation and standards

We are pleased to publish the proceedings of the workshop and wish to express our cordial thanks to all the participants for their great contributions to the success of the workshop. We hope to see you again at the fourth workshop in Boston in 1995.



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Session 1: Biodegradation of Polymers and Plastics

Chairpersons:

— R.C.Fuller, G.Scott, S.T. Huang, and M.K.Cox

SIMILARITIES AND DIFFERENCES BETWEEN BIODEGRADATION AND NON-ENZYMATIC DEGRADATION

S.J. Huang, L.-H. Ho, M.T. Huang, M.F. Koenig and J.A. Cameron.

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University of Connecticut, Storrs, Connecticut 06269-3136, U.S.A.

1. INTRODUCTION

There are increasing interests on the enzymatic degradation of polymers in recent years due to the needs in the biomedical areas for biodegradable polymer implants and controlled release systems [1-8]. Furthermore, biodegradable-bioconversion processes are becoming more and more as the most desirable means of polymer wastes management. Hydrolyses and oxidations are the primary processes for polymer degradations. Under the normal situations both enzymatic and non-enzymatic processes can occur simultaneously. It is therefore important to understand both processes.

Degradations of solid polymers start as heterogeneous multi-phase processes. As the degradations proceed the hydrophilicity of the polymers increases as the products are generally more polar than the non-degraded polymers. As the degradations proceed further weight loss, volume shrinkage, void formation, increase of surface and loss of physical properties follow. It is very difficult to study the detail kinetics since they are non-steady state processes. Nevertheless, apparent kinetics and microscopy studies have provided important information concerning the hydrolytic degradations of polymers. Among the important factors which contribute to the biodegradability of polymers are the presence of hydrolyzable and for oxidizable groups, balance of hydrophobicity and stereo chemistry. Physical properties such as crystallinity, orientation and other morphological properties, surface area etc. affect the rate of degradations.

In order to gain information in a systematic manner we have studied analogous polymer series containing one or more hydrolyzable functional groups (amide, enamine, ester, urea and urethane) and modified biopolymers in both enzymatic (buffered enzyme and microbial) and non-enzymatic degradations. Our findings, with consideration of reports from other laboratories, are discussed here in terms of factors affecting the degradations and changes resulted by the degradation processes.