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FINAL REPORT

WORKSHOP ON

**"ENVIRONMENTALLY DEGRADABLE PLASTICS MATERIALS
BASED ON NATURAL RESOURCES"**

August 29-September 2, 1999

SHANGHAI, CHINA

UNIDO PROJECT NO. : TF/GLO/96/105

CONTACT NO. : 99/160

Objectives

The main objectives of the workshop are as follows

- To promote understanding on the present research, production and application of bio-related polymers, both in the developed countries and in China and neighbouring countries, especially regarding aspects on EDPs.
- To gather experts (from universities, R&D institutions and industry) working on synthesis, processing/manufacturing and also applications of environmentally degradable polymers and respective materials with the focus on natural resources and biomedical aspects.
- To identify regional R&D institutions in China and the region of East Asia through contacts established with the participants in the workshop and to give ICS the opportunity of identifying qualified centers to be considered as future cooperative institutions for ICS Network.
- To evaluate possible follow-up project proposals of feasibility studies relevant to the subject of the Workshop, under the ICS coordination.

Organization

The workshop was organized jointly by the International Center for Science and High Technology (ICS) and Fudan University, Shanghai, China.

The local Organizing Committee consisted of :

-Prof. Ming Jiang	Department of Macromolecule Science, Fudan University; Vice-director of Polymer Prevision of Chinese Chemistry Society, Chairman
-Prof. Zhengzhong Shao	Vice-director of Department of Macromolecule Science, Fudan University, Co-Chairman
-Prof. Chi Wu	Department of Chemistry, Chinese University of Hongkong
-Prof. Guoqiang Chen	Department of Biological Science and Biotechnology, Tsinghua University(Beijing)
-Prof. Liban Chen	Guangzhou Institute of Chemistry, Chinese Academy of Sciences

Dates and Venue

The Workshop was held from August 29th to September 2nd 1999, in Shanghai, P. R. China, at the International Conventional Center of Baolong Hotel and the American Center in Fudan University, with a half day (1 September) dedicated to a visit to Shanghai Museum.

Funding

The total expense was US Dollars 36,657. The amount received from UNIDO was US Dollars 20,000 (as part of \$26,100 granted by ICS-UNIDO) to cover the accommodation of all

participants and the travelling expenses of invited lectures, both from abroad and domestic. The hosting country contributed with \$10,420. The total expenses estimated in TOR were \$36,100, which means that the actual expenses were increased slightly. This is due to the increased number of participants (1 invited lecturer from HongKong and 15 participants mainly from Shanghai and Fudan University) and most of invited lecturers stayed in Shanghai more than 5 five days because of their Flights, though the hotel provided a cheaper price for the accommodation of all the participants. The hosting University can manage this little deficit if receive the other \$6,100 (the rest of \$26,100 in TOR) from UNIDO.

A summary of final budget is given in Appendix I.

Participation:

In total 57 peoples (not including those auditors about 10 people each session) participated in the workshop: 15 invited lecturers and 42 participants.

1- Invited Lecturers

15 invited Lecturers (Table 1) from different countries and institutions have presented a total of 20 lectures covering different aspects of polymer degradation, stability, microbial polymers, plastics recycling, EDPs synthesis and solid waste management with special emphasis on plastic waste. Some Lecturers have also presented the experience of their own countries in the management of plastic waste, and samples of new products prepared from EDPs.

Table 1. Invited Lectures of the Workshop

Lecturer	Institution	Country
S. Miertus*	ICS-UNIDO International Centre for Science and High Technology	Italy
E. Chiellini	Department of Chemistry & Industrial Chemistry, University of Pisa	Italy
E. Piskin	Hacettepe University	Turkey
G. Braunegg	University of Technology Graz, Institute of Biotechnology	Austria
S. H. Kandil	Institute of Graduate Studies and Research, Alexandria University	Egypt
K. Fukuda	Biodegradable Plastics Society of Japan	Japan
Y. Doi	Polymer Chemistry Laboratory, Riken Institute	Japan
Y. H. Kim	Biomaterials Research Centre, Korea Institute of Sci. & Tech.	Korea
I. Park**	Polymer Research Center, SK Corporation	Korea
W. J. Cho	Dept. Of Polymer Science and Engineering, Pusan National University	Korea
J. I. Jin	Korea University	Korea
C. Wu	Chinese University of Hong Kong	China
G. Q. Chen	Tsinghua University	China
L. B. Chen	Guangzhou Institute of Chemistry, Chinese Academy of Sciences	China

X. M. Deng	Chengdu Institute of Organic Chemistry, Chinese Academy of Sciences	China
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* ICS Area Coordinator, Financially covered by ICS-UNIDO

** Travelling expense covered by SK Corporation

2- Participants

More than 100 application forms and invitation letters were distributed to various universities, academic institutions and industrial companies in China and neighboring countries.

42 participants (Table-2) from four countries, regularly, attended the workshop making the total number as 57 invited Lecturers and participants, representing 10 countries. 16 contributions were presented by the participants making the total presentations 36, distributed as general lectures, country reports and research papers.

Participants' affiliations included universities and Polytechnics (66%), institutions (17%), industries and R&D (17%).

The complete list of participants is attached (Appendix-2)

Table 2. Participants according to countries

Country	Number of participants
Italy	2
Turkey	1
Austria	1
Egypt	1
Japan	2
Korea	4
Canada*	1
USA**	1
Germany***	1
China (including Hong Kong)	43

* Dynamic Pacific Enterprises Co., Shanghai Office

** General Electric (USA) Plastics Ltd., Shanghai Office

*** NETZSCH Geratebau GmbH, R. O. Shanghai

Workshop Materials

Each participant was provided with a small bag containing notebook, ballpen, aide memoire, abstract of papers, program and list of all participants with their addresses.

Opening Ceremony

The Opening Ceremony chaired by Prof. Ming Jiang was held at 8:40 am, Aug 29. The opening speeches were given by the Vice-President of Fudan University, Prof. Yuliang Yang, and ICS-UNIDO area Coordinator Prof. Stanislav Miertus.

Program

The program of workshop was as follows:

August 29th: Registration and Reception

August 30th-the morning of September 1st: lectures, 4 session each day, with an average of 3 presentations in each session, time duration for each presentation ranged from 25 to 40 minutes. Each presentation was followed by a few minutes discussion. The main topics covered were:

EDPs General Aspects (2 sessions)

EDPs Biomedical Polymers (1 session)

EDPs Blends and Composites (1 session)

EDPs Microbial Polymers (2 sessions)

EDPs Synthetics and Semisynthetics (2 sessions)

EDPs Country Report and Industrial Applications (2 sessions)

The afternoon of September 1st: a visit to Shanghai Museum and Shanghai City tour.

September 2nd: Lectures, two sessions on EDPs Synthetic and Semisynthetics (Continued) and 1 sessions on Recycling and Reusing of Plastics, and finally the closing Ceremony.

(Detailed program is attached as Appendix-3).

Meetings

After the closing ceremony on Sept.2nd, a meeting was held comprising Prof. Stanislav Miertus, Prof. Emo Chiellini, Prof. Ming Jiang and Prof. Zhengzhong Shao. They evaluated the achievement of the workshop and discussed the future cooperation between ICS-UNIDO and Fudan University.

Media Coverage

The Opening Ceremony of Workshop was shot by the Cable TV station. During the time workshop, the news, as well as the aims of the workshop and the significance of using EDPs were broadcasted at least three times.

Social Events

The following social events were organized during the workshop:

August 29 (evening): Reception at Bolong Hotel

September 1st: A visit to Shanghai Museum and a city tour. Dinner at Diamond Restaurant located at Bund of HuangPu River.

September 2nd: A group photographing and a short visit in Fudan University. Dinner at Bolong Hotel

Assessment

Assessment of the workshop was performed by an optional questionnaire distributed on

participants. A summary of this assessment is given in Table 3. According to the result of this assessment, the workshop was very successful and the organization was excellent, most evaluations have been from very good to excellent.

Table-3. Summary of the Questionnaire

A. Organization	Excellent (%)	Very good (%)	Good (%)	Fair (%)	No answer (%)
Information Process	53.3	26.7	13.3	6.7	0.0
Announcement	20.0	60.0	13.3	0.0	6.7
Scientific Program	46.7	46.7	6.6	0.0	0.0
Applied lectures	26.7	60.0	6.7	0.0	6.6
Small working groups	20.0	20.0	33.3	0.0	26.7
Case studies	13.3	40.0	26.7	0.0	20.0
Time of lectures	20.0	80.0	0.0	0.0	0.0

Students Scientific Knowledge	Balanced (%)	Unbalanced (%)	No answer (%)
	80.0	13.3	6.7

B. Duration of program	Just right (%)	Too long (%)	Too short (%)
No. of days	80.0	6.7	13.3
Length of working days	86.7	0.0	13.3

C. Training Facilities & Hotel	Excellent (%)	Very good (%)	Good (%)	Fair (%)	No answer (%)
Lecture/Training room	60.0	26.7	13.3	0.0	0.0
Breaks/Refreshments	40.0	33.3	20.0	0.0	6.7
Hotel accommodation	53.3	26.7	0.0	0.0	20.0
Meals at the hotel	33.3	46.7	13.3	0.0	6.7
D. Organization Response	73.3	26.7	0.0	0.0	0.0
E. Overall Organization	60.0	33.3	0.0	0.0	6.7

F. Would you recommend to others to attend a similar activity in the future	Yes (%)	Maybe (%)	No (%)
	73.3	26.7	0.0

Closing Ceremony

The closing ceremony session, started at 16:30, Sept. 2nd, was chaired by Prof. Ming Jiang.

Professor Miertus presented a general approach on how ICS used, in the last two years, to follow up these activities by:

- Follow-up seminars which could be in general or more specialized aspects
- Publishing of proceedings
- Establishing a regional network connected to ICS-UNIDO network and data base for collecting update information on EDPs, plastic waste management, etc. And identifying

experts and institutions working in the field.

He also explained that possible project proposals could be within any of the following topics:

- ◆ technology transfer for new materials(e.g. EDPs) from industrialized countries to developing countries
- ◆ Joint research projects

Then there was a general discussion between several participants and experts in which there were several contributions and suggestions. Professor Miertus answered several questions particularly about the project proposals.


After Professor Chiellini presented his final remarks and notes covering a broad range of projects such as the active role of ICS-UNIDO in diffusion of the related concepts and technology for EDPs, drivers for developing EDP, environmental preservation policy improvement of the quality of the life etc. He answered several raised technical questions. He emphasized that it is not the policy of ICS-UNIDO to oppose the development of the more sustainable plastics as might be thought, EDPs are not the alternative for all polymers, they constitute an alternative in certain sectors of plastic utilization; coexisting with others available, for management of plastic wastes. Finally Prof. M. Jiang gave the farewell speech expressing his sincere thank to all the speakers and participants for their active contributions to the workshop and announced that the certificates will be posted later to all participants.

Results

The workshop was successful and has achieved its objectives. This can be shown from:

- the assessment of the participants,
- the discussion and the final conclusive remarks,
- and the acknowledgement letters received from various lecturers and participants.

A great concern and awareness of the environmental issues with plastic consumption and applications have been raised, EDPs and their possible applications are more understood, perceptions have been improved on certain environmental issues such as recycling and other options of waste management. Updated information on the latest technologies in the field has been exchanged between researchers, industrialists and environmentalists. The last but not the least, the understanding of the EDP experts from developed countries on the current situation of EDPs in China, particularly its research, production, application and the related policy has been pronouncedly promoted.



Prof. Ming Jiang

Appendix I

Summary of final budget

Budget as estimated in TOR		Actual expenses	
Description	Amounts in US Dollar	Description	Amounts in US Dollar
Accommodation of 9 invited international lectures/speakers (Full board for 5 days, 120 US\$/day per person)	5,400	Accommodation of 9 invited international lectures (Full board for 5 to 8 days, 100 US\$/day per person, including the costs of Reception and Banquets)	6,100
Accommodation of 3 invited lectures/speakers from the country (Full board for 5 days, 120 US\$/day per person)	1,800	Accommodation of 4 invited lectures from China (Full board for 6 days, 100 US\$/day per person, including the costs of Reception and Banquets)	2,400
Accommodation of 30 participants from the country (Full board for 5 days, 50 US\$/day per person)	7,500	Accommodation of 19 participants from vary areas in China (Full board for 5 days, two persons shared a room, 60 US\$/day per person, including the costs of Reception and Banquets)	5700
		Costs of regular meal of 23 participants from Shanghai (5 days, 30 US\$/day per person, including the costs of Reception and Banquets)	3450
Travel of 3 invited lecturers/speakers from Japan and Eastern Asia Countries (Average air-fair: 700 US\$ per person)	2,100	Travelling expanses of 2 invited lecturers from Japan and 3 invited lecturers from South Korea	2,868
Travel of 6 invited lecturers/speakers from other industrialized countries (Average air-fair: 1,400 US\$ per person)	8,400	Travelling expanses of 4 invited lecturers from other industrialized countries	4,369
Travel of 3 invited lecturers/speakers from the country (Average air-fair: 300 US\$ per person)	900	Travel of 4 invited lecturers from China (including HongKong)	1,350
Total	26,100		2,6237

Contributions of the hosting institution and National Natural Science Foundation of China (Secretariat, transport, communications, mail services, and using other facilities for the organization until the meeting)	10,000	Transport	800
		Visiting (Shanghai Museum)	320
		Advertisements and Workshop materials including notebook, ball-pen, little gift, etc	1,300
		Secretarial work including fax, stationary, postage, telephone, etc.	2,000
		A multi-medium facility	1,100
		Rent for meeting room (including facilities of presentation, and refreshments)	1,400
		Printing of Abstracts, Certificates, etc.	1,200
		Rewards for members of organization committee, secretarial staffs, etc	1,500
		Miscellaneous	800
GRAND TOTAL	36,100	Total expenses	36,657

ICS-UNIDO INTERNATIONAL WORKSHOP

--Environmentally Degradable Plastics: Materials Based on Natural Resources

Department of Macromolecular Science

Fudan University, Shanghai, P. R. China

August 29, 1999 ~ September 2, 1999

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Programme

SUNDAY, August 29, 1999

Registration (Lobby, Bao Long Hotel)

18:00~20:00 Reception

MONDAY, August 30, 1999

8:10~8:40 **Registration**

8:40~9:00 **Inauguration**

Session 1: EDPs General Aspects

Y. Doi, Presiding

9:00~9:30 **S. Miertus**--ICS-UNIDO Coordinator
Introduction to the ICS-UNIDO Programs and Activities in the Area of Pure and Applied Chemistry, with Special Focus on the Subprogramme of Environmentally Degradable Plastics

9:30~10:10 **E. Chiellini**--University of Pisa, Italy
Environmentally Degradable Polymeric Materials & Plastics (EDPs)-An Overview

10:10~10:40 **Break**

E. Piskin, Presiding

10:40~11:20 **Y. Doi**--Riken Institute, Japan
R&D of Biodegradable Polymers and Plastics

11:20~11:45 **S. Cui**--Dynamic Pacific Enterprises Co. (Shanghai Office)
Degradable Plastic Products By EPI® TDPA™ Technology

11:45~12:15 **C. Wu**--Chinese University of Hongkong, China
A Novel Method of Studying Polymer Biodegradation

12:15~14:00 **Mid-Day Intermission**

Session 2: EDPs Biomedical Polymers

S. H. Kandil, Presiding

14:00~14:40 **X. M. Deng**--Chendu Institute of Organic Chemistry, China
Synthesis and Application of Biodegradable Polymers for Biomedical Use

14:40~15:05 **X. C. Pan**--Engineering Research Center in Organic Synthesis of Chinese

Academy of Science, China
Synthesis and Characterization of Biodegradable Surgical Sutures Made from PGLA

15:05~15:30 **X. F. Zhang**--Shanghai Tianqing Biochemical Material Co., China
Development of Biomedical Textiles

15:30~16:00 **Break**

Session 3: EDPs - Blends & Composites

X. M. Deng, Presiding

16:00~16:40 **I. Park**--Polymer Research Center, SK Co., Korea
Biodegradable Polymer Compound Based on Plasticized Thermoplastic Starch

16:40~17:20 **Y. Z. Wang**--Shichuan University, China
Biodegradability of PE Films Containing Starch and Photoactivities

17:20~17:45 **L. Q. Wang**--Zhejiang University, China
A Fully Biodegradable Polymer Blend Based on the Renewable Resources

Tuesday, August 31, 1999

Session 4: EDPs - Microbial Polymers

G. Q. Chen, Presiding

8:30~9:10 **G. Braunegg**--University of Technology, Graz, Austria
Sustainable Polyhydroxyalkanoate (PHA) Production from Different Raw Materials

9:10~9:40 **S. C. Zhao**--The Institute of Microbiology, China
Trail Studies on Environmentally Degradable Poly(3-hydroxyalkanoates)

9:40~10:00 **Y. X. An**--Changchun Institute of Applied Chemistry, China
Study on Poly(β -hydroxybutyrate) and Its Blends

10:00~10:30 **Break**

G. Braunegg, Presiding

10:30~11:10 **G. Q. Chen**--Tsinghua University, China
Plastics Produced by Bacteria - Degradable Polyhydroxyalkanoates

11:10~11:50 **W. J. Cho**--Pusan University, Korea
Synthesis and Controlled Bio- and Photodegradabilities of Polymers Containing P(HBV) and Starch

11:50~14:00 **Mid-Day Intermission**

Session 5: EDPs - Synthetics & Semisynthetics

Z. Z. Shao, Presiding

- 14:00~14:40 **L. B. Chen**--Guangzhou Institute of Chemistry, China
Biodegradable CO₂ Copolymers
- 14:40~15:05 **X. P. Qiu**--Xiamen University, China
Synthesis, Characterization and Application of PVA Ferrofluids
- 15:05~15:30 **X. Y. Ni**--Fudan University, China
Enzymatic Hydrolysis of PVA Films Crosslinked with Maleic Acid
- 15:30~16:00 **Break**

L. B. Chen, Presiding

- 16:00~16:40 **E. Piskin**--Hacettepe University, Turkey
Biodegradable Polymeric Biomaterials
- 16:40~17:05 **F. R. Huang**--East China University of Sci. & Tech., China
Advance on Biodegradable Polymeric Materials
- 17:05~17:30 **G. Q. Chen**--Tsinghua University, China
Plastic Packaging Materials--Its Development, Problems and Solutions

Wednesday, September 1, 1999

Session 6: EDPs Country Report & Industrial Applications

S. Miertus, Presiding

- 8:30~9:00 **K. Fukuda**--Biodegradable Plastics Society, Japan
Biodegradable Plastics--Present and Future
- 9:00~9:25 **Ming Jiang**--Fudan University, China
Plastic Consumption, Plastic Waste Management and Development of Environmentally Degradable Polymers in China
- 9:25~9:50 **G. Braunegg**--University of Technology, Graz, Austria
Management of Plastic Waste in Austria
- 9:50~10:15 **E. Piskin**--Hacettepe University, Turkey
Plastic Waste Management in Turkey
- 10:15~10:40 **Break**

K. Fukuda, Presiding

- 10:40~11:20 **Y. H. Kim**--Korea Institute of Sci. and Tech., Korea
Recent Status of Biodegradable Plastics in Korea

- 11:20~11:45 **G. Zhu**—GE Plastics, China
Waste reduction through reuse and recycling at GE Plastics
- 11:45~12:15 **Discussion on Industrial Views on EDPs**
- 12:10~14:00 **Mid-Day Intermission**
- 14:15~20:00 **Shanghai City-tour and Banquet**

Thursday, September 2, 1999

Session 5 EDPs Synthetic & Semisynthetics (Continued)

E. Chiellini, Presiding

- 8:30~9:10 **J. I. Jin**--Korea University, Korea
Novel Biodegradable Thermosensitive Poly (organophosphasenes)-Synthesis, Hydrolyzability and LCST Properties
- 9:10~9:40 **Q. Zhou**--Wuhan University, China
Biodegradability of Regenerated Cellulose Films Coated with Polyurethane/Natural Polymer IPNs
- 9:40~10:10 **W. Zhong**--Fudan University, China
Synthesis of Biodegradable Polyurethane Foams from Condensed Tannin and Bark of Acacia Mearnsii
- 10:10~10:40 **Break**

J. I. Jin, Presiding

- 10:40~11:20 **E. Chiellini**--Pisa University, Italy
EDPs-Blends & Composites Based on Hydrosoluble/Hydroswellable Polymeric Materials
- 11:20~11:45 **H. Yu**--China Textile University, China
Development of Biodegradable Polyester Fibers
- 11:45~14:00 **Mid-Day Intermission**
- 14:00~14:30 **To Fudan University**

Y. Huang, Presiding

- 14:30~15:20 **S. H. Kandil**--Alexandria University, Egypt
 1. *Aspects on Plastic Recycling*
 2. *Thermal Degradation of Plastics Materials*
- 15:20~15:45 **Z. P. Fang**--Zhejiang University, China
Recycling of Commingled Plastics Wastes

15:45~16:20 **Group Photographing**

16:20~16:50 **Discussion on Follow-up Activities**

16:50~17:20 **Evaluation of the Workshop**

17:20~17:40 **Closing Ceremony**

17:40~18:10 **A Short Visit to Fudan University**

18:30~20:00 **Farewell Dinner**