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22438

FINAL REPORT

WORKSHOP ON

**“ENVIRONMENTALLY DEGRADABLE POLYMERS:
INDUSTRIAL DEVELOPMENT AND APPLICATION”**

September 19-22, 2000
Seoul, Korea

**UNIDO PROJECT NO.: TF/GLO/00/105
CONTRACT NO. 2000/146**

Objectives

The main objectives of the workshop are as follows;

- To discuss all the present issues related with environmentally degradable plastics (EDPs) with a focus on the industrial development and application, to demonstrate its recent developments in terms of manufacturing and processing technology of EDP, to investigate its standards and test methods, and to analyze the market development for extending the application of EDP.
- To provide participants from developing countries, especially from Asia, with updated knowledge and information on EDP in terms of the waste management of polymeric materials.
- To raise public perceptions on the issues of environmental effects of plastics and to emphasize the positive contributions of EDPs in the waste management of polymeric materials.
- To stimulate international research and technology transfer and enhance international co-operation through possible, joint, or follow-up projects, and feasibility studies by identifying regional R&D centers in developing countries through contacts established with the participants in the workshop. Thus giving ICS the possibility of identifying qualified academic and industrial centers for future joint ventures for the EDPs development.

Organization

The workshop was organized jointly by the International Centre for Science and High Technology (ICS) and the Korea Biodegradable Plastics Association (KBPA). KBPA was founded on May 1999 by the EDP manufacturers and scientists working on EDP in Korea aiming to activate R & D and to extend the application of EDP, and headed by Drs. Young Ha KIM (KIST) and Seung Soon IM (Hanyang Univ.).

The International Scientific Committee consisted of:

Stanislav MIERTUS (ICS-UNIDO, Italy), Ann-Christine ALBERTSSON (Royal Inst. Tech., Sweden), Emo CHIELLINI (Univ. of Pisa, Italy), Yoshiharu DOI (RIKEN, Japan), Ming JIANG (Univ. of Fudan, China), Jung-Il JIN (President, Korean Chemical Soc.), Kwang Ung KIM (President, Polymer Soc. of Korea), Young In PARK (USGrains Council Korea), and Patrick GRUBER (Dow Cargill Polymer, U.S.A).

The Local Organizing Committee consisted of:

Chairman: Young Ha KIM (KIST)

Co-Chair: Seung Soon IM (Hanyang Univ.)

Secretary: Soo Hyun KIM (KIST)

Members: Yang-Kyoo HAN (Hanyang Univ.), Byong R. MIN (USGrains Council),

Hye-Jung KANG (ATS), Dong Kook KIM (Hanyang Univ.),

Ji-Heung KIM (Sungkyoonkwan Univ.), Sang Yup LEE (KAIST),

Pyong Kyun SHIN (KIST), Daewon SOHN (Hanyang Univ.)

Young Deuk YOO (SK Corporation), Jin-San YOON (Inha Univ.)

Dates and Venue

The Workshop was held from September 19 to 22, 2000 in Hanyang University, at the Paiknam Information Center building, Seoul, Korea.

Funding

The total expense as estimated in TOR was U.S. Dollars 40,000. The amount approved by UNIDO was U.S \$30,000 to cover the travel and accommodation expenses of all the invited speakers and participants. In addition, \$ 10,000 by Korean contribution was estimated in TOR for the operation of the workshop and publication of the circular, abstracts, and proceedings. The actual domestic contribution was about \$ 14,000, \$ 7,000 from The Korea Science and Engineering Foundation and \$ 6,000 from US Grains Council, and \$ 1,000 from workshop fee/ exhibition for industrial participants . In addition, US Grains Council supported independently to invite 2 foreign speakers among the planned list (P. Gruber and G. Braunegg) and to sponsor the banquet, which was very appreciated. Hanyang Univ., the hosting institution, has also thankfully sponsored the welcoming reception and offered the conference hall free.

The actual total expense was \$ 43,463, about 10 % larger than the planned one, excluding the contribution from US Grains Council and Hanyang Univ.. A summary of the final budget is given in Appendix 1.

The Actual total expenses from the UNIDO-ICS budget amounted to US\$ 29,512, therefore it mostly coincided with the estimated one (US\$ 30,000). This means that, beside the first tranche which was already transferred by UNIDO (US\$ 24,000), a second tranche of US\$ 5,512 has to be transferred to fit with the final balance.

The actual expenses for the accommodation/meals of international lecturers were \$11,645, more than the planned \$ 10,000. This difference was produced as several speakers should have stayed longer than expected due to the necessary connections of their flights. The travel cost of international lecturers was \$ 12,736, smaller than the planned one \$ 15,000, because 2 speakers were supported independently by US Grains Council. Most of the invited speakers from industries attended to the workshop by their own expenses. The accommodation/meals of domestic participants cost \$ 2,922, although the number was much larger (104) than expended (40-50). The publication cost should be increased, because the proceeding was not planned before maybe by a miscommunication.

Participation

In total 141 persons from 16 countries are participated in the Workshop, among them 37 from abroad and 104 domestic. There were 34 lectures by 33 speakers; 28 lectures from abroad and 6 domestic. We had 28 foreign invited speakers including 7 from industries invited but attended by their own expenses.

1. Lectures

In total 34 lectures by 33 invited speakers (Table 1) from 16 countries and different institutions were presented in the workshop covering all the aspects of EDP; manufacturing and processing technology, standards and test methods of biodegradation, and marketing development of EDP. Among 34 lectures, 10 were from industry to demonstrate the technical development of EDP made of polylactic acid, aliphatic polyester, modified starch and photodegradable additives. Those companies were represented by Cargill Dow Polymer (U.S.A.), Novamont (Italy), Mitsui Chemicals, Daicell Chemical Industry, Showa Denko K.K. (Japan), Ire Chemical (Korea), Tianjin Danhai Co.(China), and Environmental Products Inc.(Canada). In addition, 13 National Reports were presented to describe the waste treatment system and the R & D status of EDP in each country, such as Austria, Slovak, Japan, Korea, China, Taiwan, Indonesia, Thailand, Malaysia, Singapore, Philippines, and Vietnam focused in Asian countries.

Table 1-1. Invited lecturers and national representatives of the Workshop

No.	Lecturer	Institution	Country
1	S. MIERTUS	UNIDO-ICS	Italy
2	E. CHIellini	Univ. of Pisa	Italy
3	P. GRUBER	Cargill Dow Polymer	USA

4	Y. DOI	RIKEN	Japan
5	G. BRAUNEGG	Univ. Tech. Graz	Austria
6	S.Y.LEE	KAIST	Korea
7	R. NARAYAN	Michigan State Univ.	USA
8	H. SAWADA	ISO WG on EDP	Japan
9	Y. TOKIWA	NIBHT	Japan
10	D. BAKOS	Slovak Tech. Univ.	Slovak
11	K. OHSHIMA	JBPS	Japan
12	Y.H. KIM	KIST	Korea
13	S. TANG	Chinese Soc. for Degradable Plastics	China
14	S-Y. LEE	Union Chemical Lab.	Taiwan
15	S.S. IM	Hanyang Univ.	Korea
16	Y-K.Han	Hanyang Univ.	Korea
17	S.H. KIM	KIST	Korea
18	D. HUTMACHER	Nat. Univ. Singapore	Singapore
19	K. SUCHIVA	MTEC	Thailand
20	M. JIANG	Fudan Univ.,	China
21	P. AGAMUTHU	Univ. Malaya	Malaysia
22	M. YUSMAN	AAAT	Indonesia
23	E. CARINO	DENR-EMB	Philippines
24	T.Q.NGUYEN	Inst. of Industrial Chemistry	Vietnam

Table 1-2. Invited lecturers from industries of the Workshop

No.	Lecturer	Institution	Country
1	T. YAGI	Mitsui Chemicals	Japan
2	G.SWIFT	G S Polymer Consultants	USA
3	G.GHISLANDI	Novamont	Italy
4	M. ITO	Daicel Chemical Ind.	Japan
5	E. KITAKUNI	Showa Denko KK	Japan
6	D. WILES	Environmental Products Inc.	Canada
7	D.H.KIM	Ire Chemical	Korea
8	X. CHANG	Shanghai TianQing Biomaterials Ltd.	China
9	S. QUAN	Tianjin Dan Hai Co.	China

2. Participants

In order to advertise the workshop, a number of announcing leaflets were circulated to many academic institutions and industrial companies in Korea and neighboring countries. In addition, the final program was distributed to most of the domestic universities and industries in Korea. Throughout such efforts, more than 100 domestic scientists were participated in spite of the semester in the universities.

In total 141 were attended to the workshop from 16 countries, among them 37 from abroad and 104 from domestic (Table 2). About 20 % of the audience was from industries to represent their interests.

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

Table 2. Participants (total 141) according to countries

Country	No. of attendee	Country	No. of attendee
Austria	1	Philippines	1
Canada	1	Singapore	1
China	6	Slovakia	1
Germany	1	Taiwan	1
Indonesia	1	Thailand	1
Italy	3	U. S. A.	5
Japan	11	Vietnam	1
Malaysia	2	Korea	104

3. Exhibition of EDP Products

Several items made of EDP including EDP material and processed films and consuming products were exhibited to demonstrate the technical development of EDP manufacturing and processing. Those companies are listed in Table 3 below.

Table 3. Companies participated in exhibition

No.	Company	Country	Item
1	Daesang Corp.	Korea	EDP based on modified starch
2	Environmental Products Inc.	Canada	Bio/photo-disintegrable polyolefin
3	Ire Chemical	Korea	EDP based on aliphatic polyester
4	Samsung Color Co.	Korea	EDP based on aliphatic/aromatic polyester
5	SK Corp.,	Korea	EDP based on modified starch and on aliphatic polyester

Workshop Materials

Each participant and lecturer was provided with the workshop abstracts in addition to complimentary gift and information sheets. The main workshop materials are; Program and Abstracts of papers, List of all participants with their addresses, and Brochure about ICS and its Activities.

Opening Ceremony

The Opening Ceremony was attended by several invited guests. The opening speech was by the

Workshop Chairman Dr. Young Ha KIM, KIST, and by Prof. Stanislav Miertus, ICS-UNIDO Coordinator, followed by a congratulating remark by Prof. Mario Scalet, Scientific Attache, Embassy of Italy in Korea, and finally welcoming address by President Chong Yang KIM, Hanyang Univ., the host institution.

Program

The workshop program was as follows:

September 19 (Tu): After the brief opening ceremony, 11 lectures (each 30 min.) were delivered divided into 4 sessions on General aspects of EDP, EDP based on PLA, PHB, and EDP standards and tests. Each presentation was followed by few minute discussion.

September 20 (W): 13 lectures (each 30 min.) were presented in 2 sessions on Country report I and EDP based on aliphatic polyester and starch.

September 21 (Th): In the morning 6 lectures (each 30 min.) were presented in 2 sessions on Application of EDP and Country report II. In the afternoon we had the symposium tour to visit the places related with EDP.

September 22 (F): In the morning 4 Country reports III (each 30 min.) were delivered and the workshop ended about 1 PM.

Detailed program is shown on the first few pages of the book of abstracts.

Closing Session

After all the presentation, there were **“Round Table Discussion on Follow-up Initiatives”** and **“Recommendation and Conclusion”** for 12:00-1:00 on Sep. 22 before the farewell speech of Drs. Y.H.Kim and S. Miertus. (Certificates will be posted soon to all participants)..

The contents of the workshop was summarized by Prof. E. Chiellini and the positive role of EDP was emphasized based on **“Chemical Industry’s Responsible Care Program”**, **“Sustainable Development”**, and **“Environmental Protection”**. Several **recommendations and conclusions** were extracted in terms of; 1. Waste treatments and legislation related with plastic waste by Drs. Y.H.Kim, G.Braunegg, and P.Agamuthu, 2. Status of EDP technology and market development by Drs. T.Yagi, E.Kitakuni, and G.Swift from industries. 3. EDP standards and tests by Prof. R.Narayan.

Finally Prof. **S.Miertus** explained the activities and approach of ICS in the chemistry area focused on the EDP concept as a part of sustainable development and presented **Future activities and Follow-up activities;**

- Future workshop on EDP planned on 2001 maybe in Indonesia and on 2002 in other

Southeast /East Asia.

- Short meetings among governmental representatives and decision makers for providing worldwide information, trends, and experience of EDP related with plastic waste treatment.
- Establishing a regional network connected to ICS-UNIDO network and data base for collecting updated information on EDPs, plastic waste management, etc. and identifying experts and institutions working in the field.
- Possible project proposals within any of the following topics: Technology transfer of EDP from industrialized countries to developing countries, Feasibility studies, Joint research projects, and Training package program.
- Publication of Proceeding of the workshop and Comprehensive country report.

Meetings

On September 22 after the workshop, a meeting was held among Prof. Stanislav Miertus, Prof. Emo Chiellini, Prof. Mario Scalet, Science Attache of the Italian Embassy in Korea, and Dr. Young Ha KIM. Prof. Miertus and Prof. Chiellini explained the significance of the workshop and the possible future cooperation between Korea and the ICS in the area of EDP.

Social Events

1. Reception

The welcoming reception was sponsored by the President of Hanyang Univ., Chong Yang KIM on Sep. 18 (M) evening. The speakers from abroad and domestic were invited.

2. Banquet

The banquet was sponsored by US Grains Council in the evening of Sep. 21 (Th) at a Korean restaurant. All the attendee were invited.

Assessment

Assessment of the workshop was preformed by an optional questionnaire distributed to participants. According to the result of this assessment the workshop was very successful and the organization was excellent, most evaluations have been very good to excellent. Active participation of industries contributed for the meaningful program and the national reports were attractive to the most attendee. All the participants were satisfied with the meeting facility,

accommodation and meals.

Results

- In the workshop all the present issues related with EDPs were discussed with a focus on the industrial development and application and standards and test methods. EDP market development was analyzed and expected to have about 10% replacement of the conventional plastic in the near future.
- The participants from developing countries, especially from Asia, were provided with updated knowledge and information on EDP in terms of the waste management of polymeric materials.
- The positive contribution of EDP was emphasized in the waste management of polymeric waste. All the speakers and attendee agreed in that the proper waste treatment system of especially plastic waste should be established and the positive contribution of EDP for the purpose.
- The international co-operation was stimulated through possible, joint, or follow-up projects by identifying regional R&D centers in those countries through contacts established with the participants in the workshop. ICS can identify qualified academic and industrial centers for future joint ventures for the EDPs development.

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

- The relatively large number of participants; 104 from domestic and 37 from abroad, and more than 20% from industrial sector.
- The balanced (after the comment of attendee) program presented from academic and , especially, from industries.
- The comprehensive issues of EDP were discussed covering all the kinds (starch, aliphatic polyester, PLA, PHB) and all the aspects of EDP (technology and market development, standard and test, future aspect).
- The exhibition session to demonstrate the actual EDP products to the participants, especially to those not so familiar to EDP from Southeast Asian countries.
- The assessment of the participants,
- The discussions and the final conclusive remarks,
- And the acknowledgement letters received from various lectures and participants.

Finally, Korea is the most dense small country, but several million tons of plastic is produced and consumed to leave tons of plastic waste which is just landfilled mainly. Therefore, this workshop in Korea was very meaningful to raise the problem, to activate the R & D of EDP, and to teach the example to the other countries in Southeast Asia.

Future Activity

Such a workshop should be followed by various effective **follow-up activities** as Prof. S. Miertus, Area coordinator of ICS-UNIDO emphasized. It is also very important as EDP should be continuously developed as a part of sustainable development from the difficult economical justification for the moment. Therefore, the following projects should be proceeded in the future;

- Establishing an international network connected to ICS-UNIDO network and data base for collecting updated information on EDPs and plastic waste management, and combining players in academy and industry working in the field. Korea might be a candidate for the regional centre in Asia.

- Additional workshops on EDP in Asia for further encouragement: already discussed to have one on 2001 maybe in Indonesia and on 2002 in other Southeast /East Asia.

- Design of strategy and mechanism for extending EDP in Korea and other countries: As one of the practical methods, **short meetings** are necessary among governmental representatives and decision makers for providing worldwide information, trends, and experience of EDP related with plastic waste treatment. **Such a short meeting for Asian area can be organized at the foregoing EDP workshop for eg. on 2001 in Indonesia.**

Future project proposals possible for the development of EDP in Korea;

1. Application of EDP to biomedical products.

In present the R & D activity of EDP, such as polyglycolic acid and polylactic acid, in Korea for the application to biomedical products, such as biodegradable suture, internal bone fixation, or tissue engineering is very comprehensive to yield some commercial products. As there are several companies in EU and Italy already active in this area, an international cooperating program can be planned. Preliminary evaluation will be followed by Dr. Y.H.Kim before submitting a proposal.

2. Development of foamed EDP products.

In Korea, China, Japan, and other Asian countries, the lunch-box is very popular. For the moment expanded (foamed) polystyrene (EPS) is used as the material to keep rice and soup warm for up to several hours. As EPS is voluminous and therefore very difficult to be recycled, the lunch box made of EPS has been almost banned or discouraged in these countries. There are yet several difficulties to replace EPS with foamed EDP based on aliphatic polyester or modified starch; processing technology, strength, and price. As there are practical market, several industrial companies in EU and Japan will be interested to form an international

cooperation. Preliminary evaluation will be followed by Dr. Y.H.Kim before submitting a proposal too.

Appendix 1. Summary of the Final Budget

1. ICS-UNIDO Contribution

Description	Planned in TOR (US \$)*	Actual expenses (US \$)*
Accommodation/meals of invited international lecturers	10,000	11,645
Accommodation/meals of domestic lecturers	1,000	1,091
Accommodation/meals of domestic participants	3,000	2,922
Travel of invited international lecturers and participants	15,000	12,736
Transport (bus rent between hotel and meeting place)	1,000	1,118
Subtotal	30,000	29,512

* Exchange rate of 1 US \$ is 1,100 Korean Won.

2. Contribution of Korea

Description	Planned in TOR (US \$)*	Actual expenses (US \$)*
Conference hall	1,000	0 (sponsored by Hanyang Univ.)
Fax/telephone/post	2,000	2,603
Training materials	1,000	1,420
Secretariat	1,500	1,364
Possible contribution for local participants	2,000	2,200
Publication of workshop abstracts	2,000	For circular 637 for abstracts 1,693 for proceeding** 3,865 subtotal 6,364
Subtotal	10,000	13,951
Grand total	40,000	43,463

* Exchange rate of 1 US \$ is 1,100 Korean Won.

** Estimated price

3. Detailed budget of ICS-UNIDO contribution on items (All the receipts are attached)

A. Travel and accommodation of international lecturers (unit: thousand Korean Won *)

No.	Lecturer	Country	Airfare	Hotel	Meal	Total
1	E. CHIELLINI	Italy	920	510	300	1,730
2	Y. DOI	Japan	830	530	250	1,610
3	R. NARAYAN	USA	1,500	660	300	2,460
4	H. SAWADA	Japan	530	530	250	1,310
5	Y. TOKIWA	Japan	620	400	200	1,220
6	D. BAKOS	Slovak	710	510	300	1,520
7	K. OHSHIMA	Japan	830	530	250	1,610
8	S. TANG	China	600	350	250	1,200
9	S-Y. LEE	Taiwan	650	310	200	1,160
10	D.HUTMACHER	Singapore	940	270	200	1,410
11	K. SUCHIVA	Thailand	550	350	250	1,150
12	M. JIANG	China	700	510	300	1,510
13	P. AGAMUTHU	Malaysia	690	790	350	1,830
14	M. YUSMAN	Indonesia	810	440	300	1,550
15	E. CARINO	Philippines	630	440	300	1,370
16	T.Q. NGUYEN	Vietnam	920	440	300	1,660
17	S.S. IM **	Korea	1,580	---	200	1,780
18	X. CHANG	China	---	440	300	740
	Subtotal		W14,010 \$ 12,736	W 8,010 \$ 7,282	W 4,800 \$ 4,363	W 26,820 \$ 24,381

* Exchange rate of 1 US \$ is 1,100 Korean Won.

** Invitation to workshop from Univ. Massachusetts, USA staying for a sabbatical year.

B. Accommodation of domestic lecturers (unit: thousand Korean Won *)

No.	Lecturer	Country	Accommodation
1	S.Y.LEE	Korea	200
2	Y.H. KIM	Korea	400
3	Y-K.Han	Korea	200
4	D-H. KIM	Korea	200
5	S.H. KIM	Korea	200
	Subtotal		Korean W 1,200 (US \$ 1,091)

C. Accommodation of domestic participants

No.	Item	Amount (Korean Won)
1	Workshop lunches for 9.19-22	1,219,000
2	Dinners in groups (15 Items)	1,995,585
	Subtotal	3,214,585 (US \$ 2,922)

D. Transport (bus rent) : 1,229,800 Korean Won (US \$ 1,118)

4. Printing budget of Korea contribution on items (All the receipts are attached)

A. Circular : Korean Won 700,590

B. Workshop Abstracts : Korean Won 2,048,200

C. Workshop Proceedings : Korean Won 4,251,000

Subtotal: Korean Won 6,999,790 (US\$ 6,364)

Appendix 2. Participants list



ICS-UNIDO INTERNATIONAL WORKSHOP

Environmentally Degradable Plastics: Industrial Development and Application

September 19-22, 2000, Seoul, Korea

Participants List

Organized in cooperation with

Korea Biodegradable Plastics Association

Co-sponsored by

Korea Science and Engineering Foundation

U S Grains Council

The Polymer Society of Korea

The Korean Chemical Society

I. Participants from countries

Austria

Gerhart Braunegg

Hideo Sawada

Yutaka Tokiwa

Tadashi Yagi

Canada

David M. Wiles

Malaysia

P. Agamuthu

Joo Fai Tung

China

Jingping Gao

Ming Jiang

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Saizhen Tang

Jingao Yu

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Philippines

Elizabeth L. Carino

Singapore

Dietmar W. Hutmacher

Germany

Holfeld Oliver

Slovakia

Dusan Bakos

Indonesia

Mohamad Yusman

Taiwan

Shyh Yang Lee

Italy

Emo Chiellini

Giovanni Ghislandi

Stanislav Miertus

Thiland

Krisda Suchiva

Japan

Atsushi Abe

Yoshiharu Doi

Masanori Ito

Nobuyuki Kawashima

Kudo Kenichi

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Kazushi Ohshima

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Daniel Goldberg

Patrick R. Gruber

Michael N. Mang

Ramani Narayan

Graham Swift

Vietnam

Nguyen Thi Quy

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Hyuk Choi
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S. S. Choi
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Yang-Kyoo Han
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Dong-Hoon Kim
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Soo-Min Kim
Wan-Kil Kim
Tae-Wan Kim
Tae-Wook Kim
Ung-Han Kim
Young-Chul Kim
Young Joo Kim
Young Ha Kim
Joong Hyun Kwon
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