KRICT's
Eco-Friendly Plastic Innovation

17 July 2025

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Principal Researcher
KRICT

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1. Scientific & Technological Issues of Plastics -1

1. Challenges in Developing Biodegradable & Bio-Based Materials

-Eco-friendly plastics (PLA, PHA) lack performance and price competitiveness
-Often do not fully decompose in natural environments
-Compete with food resources (e.g., corn, sugarcane-based materials)

2. Advancing Recycling Technologies

-Quality degradation during mechanical recycling
-Low economic feasibility and energy efficiency of chemical recycling (e.g., depolymerization, pyrolysis)
-Insufficient sorting and purification technologies for mixed plastics

3. Detection & Reduction of Microplastics

-Lack of precise detection technologies
-Standard is lacking; difficult to remove from oceans, soils, and drinking water
-Limited scientific research on impacts to human health and ecosystems

1. Scientific & Technological Issues of Plastics -2

4. Circular Economy-Oriented Product Design (Eco-Design)

-Need for single-material designs that are easy to recycle
-Lack of design technologies based on Life Cycle Assessment (LCA)
-Insufficient structural innovation to minimize plastic usage

5. Smart Waste Management Technologies

-Need to develop AI and IoT-based sorting and collection systems
-Inadequate data systems for tracking and managing plastic waste
-Low adoption of automation-based sorting and classification technologies

6. Mismatch Between Policy & Technology

-Lack of certification standards and verification systems for biodegradability
-Regulatory barriers hindering the adoption of innovative technologies
-Insufficient policy flexibility to keep pace with technological advancements

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I-1. Introduction to KRICT

Mission Statement

A government-funded research institute specializing in chemistry, dedicated to developing core chemical technologies and solving national and societal challenges

History

- Dec 2023 **Established Yeosu Carbon Neutral Demo-Plant Center**
- Mar 2016 **Established Center for Bio-based Chemistry in Ulsan**
- Mar 2012 **Established Research Center for Advanced Specialty Chemicals in Ulsan**
- Jan 2002 **Established Korea Institute of Toxicology as an annex of KRICT**
- Sep 1976 **Established Korea Research Institute of Chemical Technology (KRICT) within the Daedeok Innopolis as a government-funded research institute, with participation from the government and 137 chemical companies**

I-2. Key Research Fields

Environmentally Friendly Chemical Process Technology

- Commercialization of chemical recycling technology for waste plastics
- Commercialization of MOF, moisture-adsorbing nanoparticle, technology
- Development of a highly efficient hydrogen production catalytic process using ammonia

Innovative Drug Discovery and Biotechnology

- Commercialization of a proven AIDS treatment
- "Ivaltinostat", a treatment for pancreatic cancer, orphan drug designation from the U.S. FDA

Chemical Platform Infrastructure

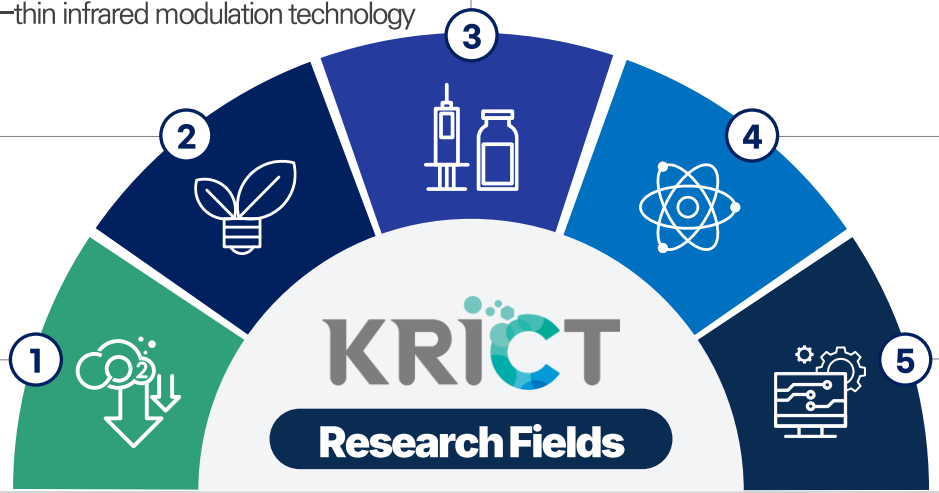
- Operation of the 'Korea Chemical Bank', a library of materials for new drug development
- Provision of an integrated research platform web service for chemical materials

High Value-added Chemical Materials

- Development of materials for Perovskite solar cell and lithium secondary batteries
- Graphene for non-invasive blood glucose sensor technology and ultra-thin infrared modulation technology

Bio-based Chemical and Green Fine Chemical Materials

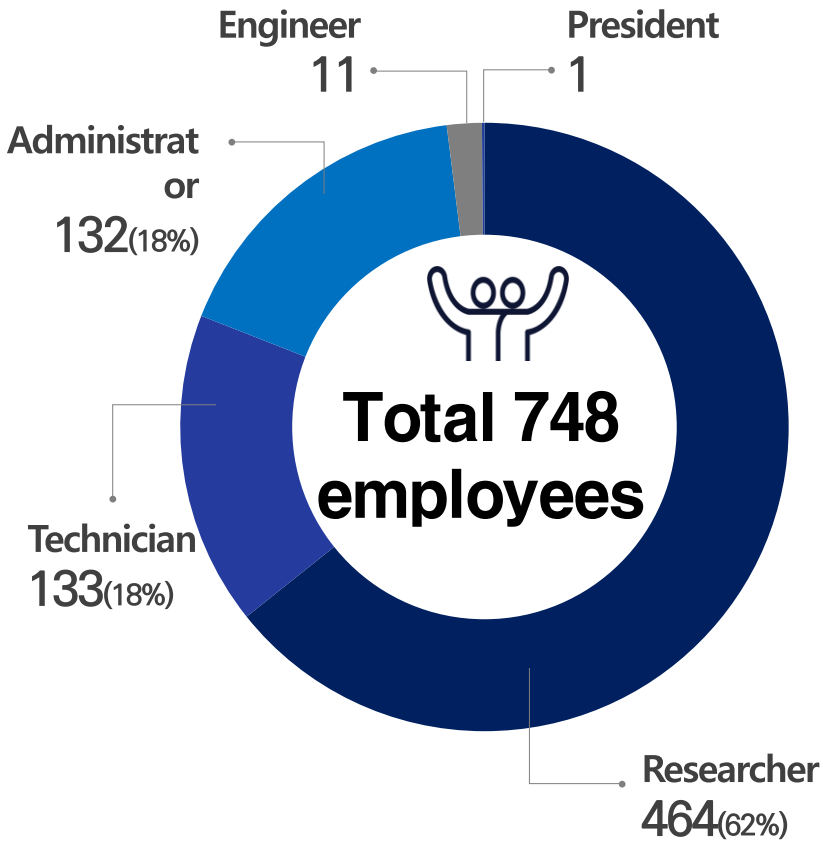
- Development of a coating substance that utilizes solar power for autonomous self-healing
- Development of 100% biodegradable paper straws



I-3. 2025 Personnel & Budget

Personnel

(As of Feb 2025)



Budget

(As of 2025)

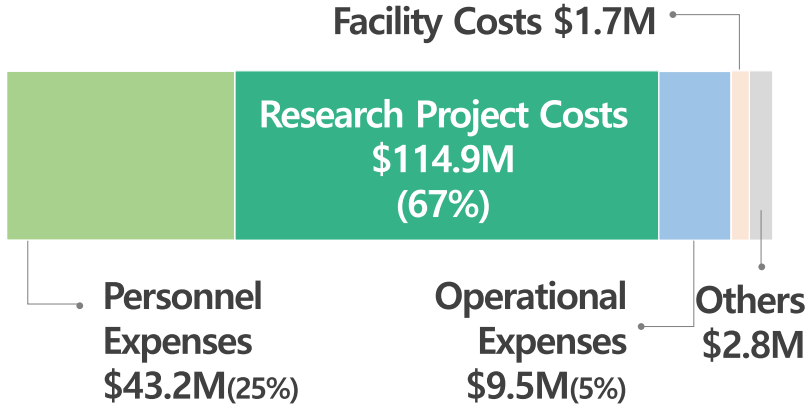
Total Revenue

$172.1M (KRW 230B)

Other Revenue $111.9M (59%)	Government Subsidies $70.2M (41%)

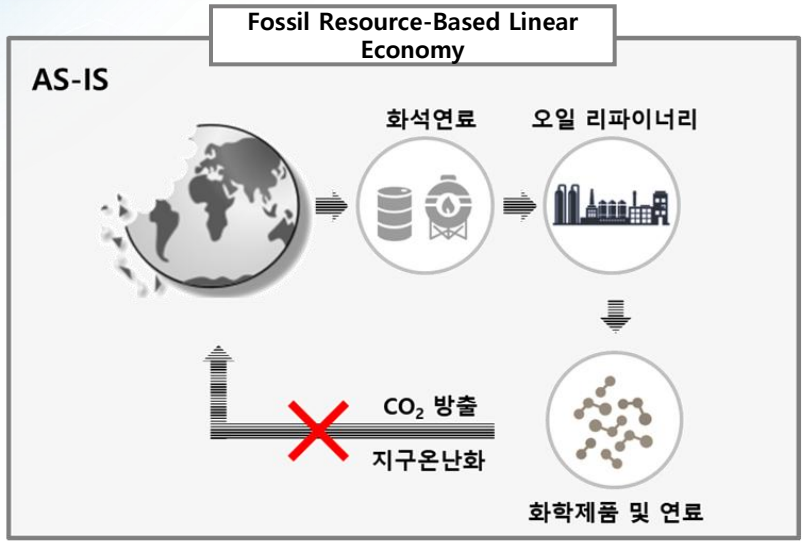
Total Expenditure

$172.1M



Contents

1. Eco-Friendly Chemical Process Technologies for Plastic Value-Up



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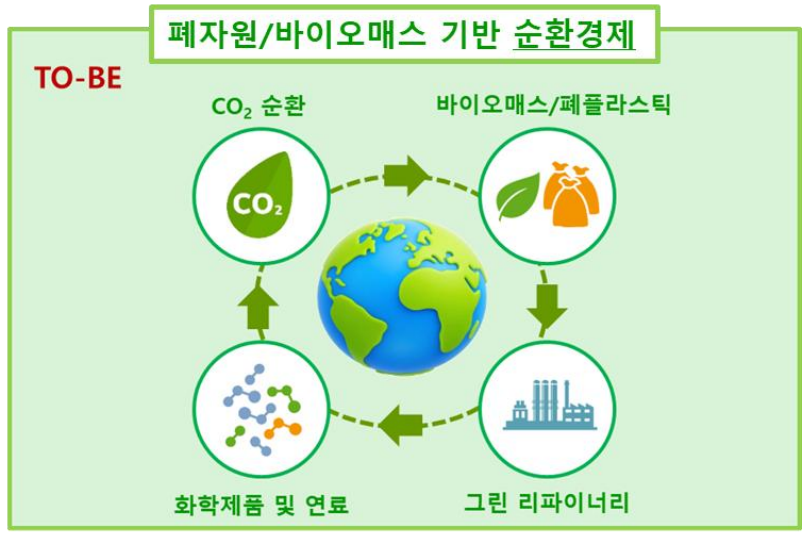
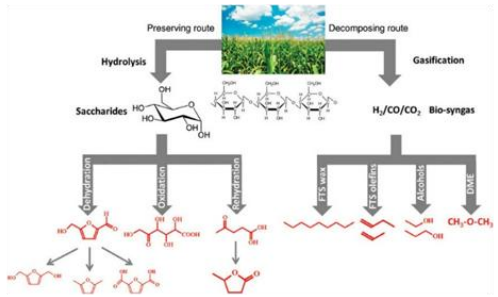
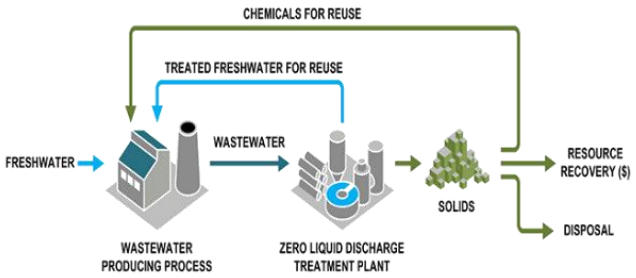
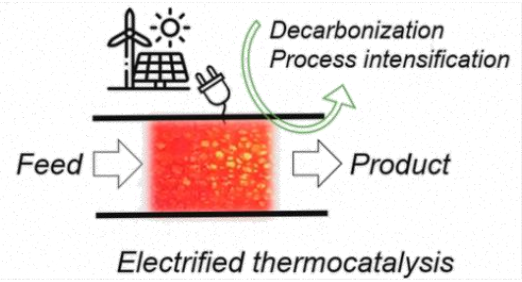




Resource Recovery from Waste Plastics/Biomass



Reduction/Minimization of Environmental Pollutants



Process Energy Efficiency

1. Eco-Friendly Chemical Process Technologies for Plastic Value-Up

Rapid Increase in CO_2 Emissions from the Fossil-Based Plastic Industry

- By 2050, CO_2 emissions are projected to reach 6.5 Gt (more than 15% of global CO_2 emissions)
- When using CFE, carbon-free energy, and biomass, CO_2 emissions can be reduced by 75% compared to conventional plastic production processes

Three Major Carbon Sources in the Chemical Industry by 2050: CO_2, Biomass & Waste Plastic

**Estimated shares of carbon sources: 50% CO_2, 34% biomass, 16% waste plastic*

Waste Plastic Depolymerization & Biomass Conversion Technologies

Current technologies are insufficient to achieve industrial-scale Net Zero targets

- Biomass conversion needs to scale up 15.5x; waste plastic requires 5.6x scaled-up technologies

Low Material Properties of Current Biomass-Derived Plastics

- Technologies must be developed to manufacture biomass-derived monomers that match the properties of fossil-based plastics

Only When Biomass and Waste Plastic Conversion Rates Exceed 50%

can significant CO_2 reduction can be achieved,

Therefore, continuous and focused research is key.

1. Eco-Friendly Chemical Process Technologies for Plastic Value-Up

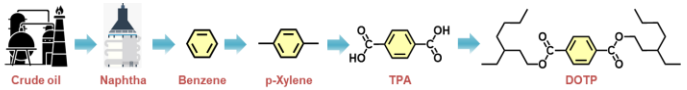
Technical Challenges

Depolymerization Process Technology for Waste Plastics

- Low economic feasibility due to high separation costs for mixed materials and colored plastics

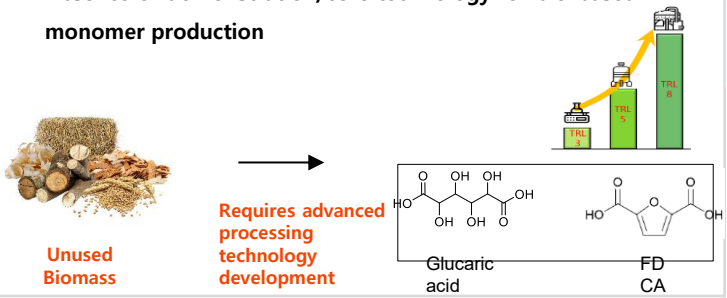
- Need for demonstration and optimization technologies for PS depolymerization

- Complex fossil-based plasticizer production process



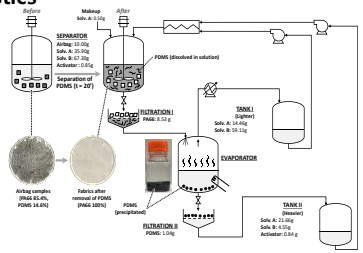
Biomass Conversion Process Technology

- Lack of advanced technology for producing pure bio-based plastic monomers as fossil-based plastic alternatives
- Absence of demonstration/core technology for biomass-based nylon monomer production
- Absence of demonstration technology for biomass-based PEF monomer production
- Absence of demonstration/core technology for bio-based PAN monomer production

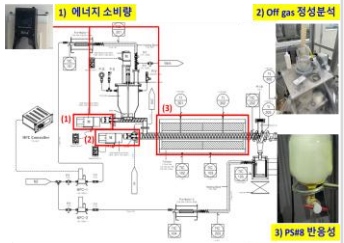


Solutions

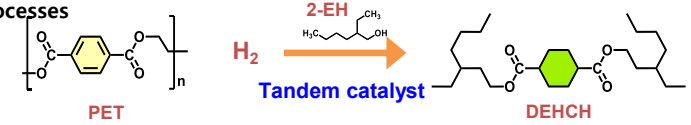
- Development of integrated recycling technologies for depolymerization and purification of mixed-material plastics



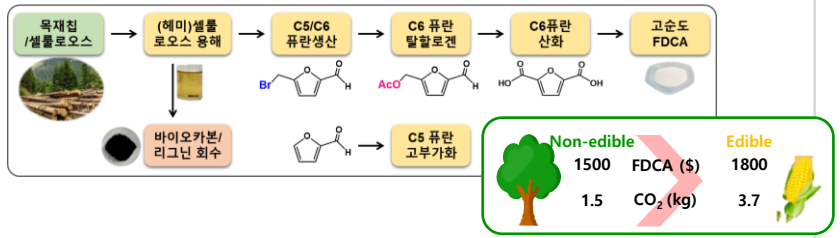
- Development of continuous PS depolymerization process demonstration technology



- Development of PET/polyester-based plasticizer production using catalytic processes



- Development of demonstration process technology for high-efficiency, eco-friendly FDCA production from non-edible lignocellulosic biomass



- Development of selective depolymerization/conversion technology for lignocellulose
- Development of catalytic process technology for selective cleavage of C-O/C-H/C-O bonds
- Development of catalytic-separation process technology for simultaneous conversion of biomass and Co2

Key Achievements of PET Recycling Chemical Process Technology

Stage for Securing Core Technology | **Stage for Scaling Up Core PET Depolymerization Technology**

Technology transfer of core PET depolymerization technology conducted (RenewSystem, Terracle, Siontech)

Construction and commissioning of commercial-scale plant
Technology transfer of PU low-temperature depolymerization and material separation

Demonstration research for entry into overseas markets (Initial achievement of technology and reapplication abroad)

Completion of PET depolymerization core technology development

Phase 1 ('20~'22)

- PET methanolysis and transesterification reaction technology, Alkali hydrolysis technology, PET glycolysis reaction technology (total of 5 technology transfer cases)

Securing key scale-up technologies for PET depolymerization

Phase 2 – Year 1 ('23)

- Technology transfer of PU low-temperature depolymerization (1 case)
- Technology transfer of BHET integrated production process (1 case)
- Technology transfer of polymer material separation (2 cases)
- Construction of a demo plant (10,000 tons/year scale) for DMT production via methanolysis and production of terephthalate derivatives via transesterification

Demonstration plant (10KTA commercial)

Optimization of PET depolymerization demo plant – 10KTA

Phase 2 – Year 2 ('24)

- Repeated operation of commercial equipment and product evaluation
- Domestic and international eco-friendly certifications (for both product and process)
- Global promotion and securing of potential customers (Chemical and textile industries in France, USA, UK, Germany, and Spain))
- Construction of a demineralization pilot and linkage with depolymerization equipment (to establish waste clothing recycling technology)
- Public broadcasting promotion of alkali hydrolysis and Series A investment secured (KRW 10.5B)

Commercial Launch of PET Depolymerization Technology – 10KTA

Phase 2 – Year 3 ('25)

- Initial sales of upcycled products (DOTP)
- Expansion of PET/PU depolymerization plants and full-scale production
- Acquisition of key technologies for continuous process improvement
- Technology transfer and commercialization of newly developed technologies (e.g., low-temp nylon depolymerization, mixed polymer separation)
- Attempts to transfer technology overseas (including JV agreements)

Key Achievements of PS Recycling Chemical Process Technology

Stage for Securing Core Technology | **Stage for Scaling Up Core PET Depolymerization Technology**

Technology transfer from KRICT to Lotte Chemical completed, Upfront license fee secured

1st milestone of technology transfer to Lotte Chemical achieved, License fee secured

Focus on scale-up research to achieve 2nd milestone of KRICT-Lotte Chemical technology transfer

Completion of core PS depolymerization technology

Establishment of key scale-up technologies for PS depolymerization

Optimization of PET depolymerization demo plant – 10KTA

Optimizing key scale-up technologies for PS depolymerization

Phase 1 ('20~'22)

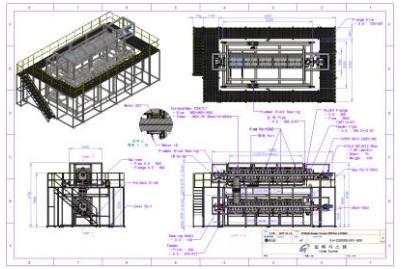
"Catalyst and continuous depolymerization process for waste polystyrene"

Phase 2 – Year 1 ('23)

- Depolymerization testing by type of waste plastic feedstock
- Establishment of scale-up technologies for the reaction system (feed input/reaction/separation & purification)
- Development of technology for using recycled raw materials
- Core technology patent registered
- Selected among the Top 100 Outstanding National R&D Achievements of 2023

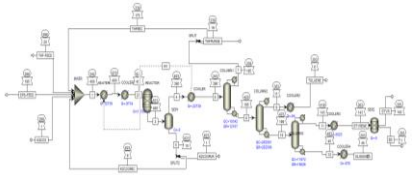
Phase 2 – Year 2 ('24)

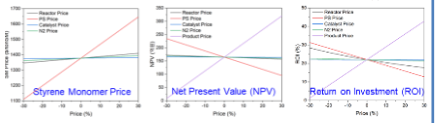
- Process design for a 10 tons/day pilot plant
- Design of continuous catalyst/feedstock injection process
- Securing design technology for continuous screw-type reactors
- Securing pilot-scale process design parameters



Phase 2 – Year 3 ('25)

- Optimization of process design for pilot plant (max. 10 tons/day capacity)
- Automated process system design
- Optimization of energy consumption and validation of economic feasibility





2. Recycling & Remolding Technology of Thermosetting Resins

Recycling & Remolding Technology of Thermosetting Resins

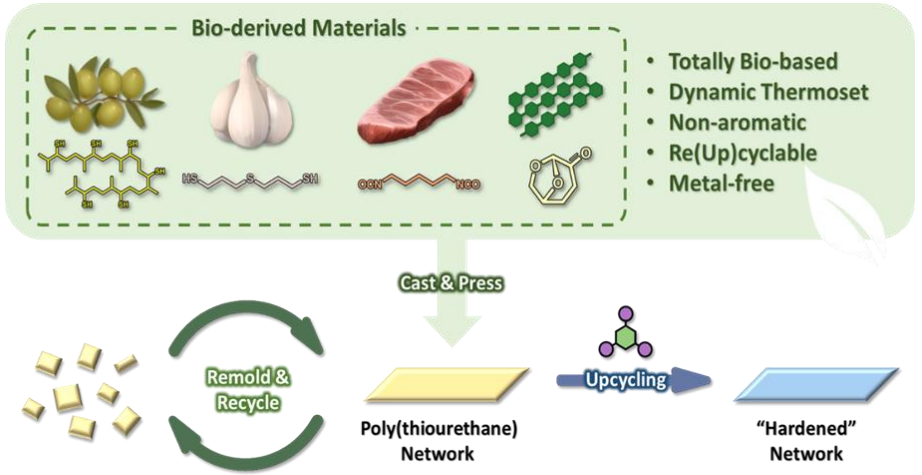
폴리우레탄 시장 규모
(고분자 소재)

약 31%: 재활용 불가능 열경화성 소재
(코팅소재, 구조용 재료, 폼 등)

"다이나믹 화학 반응을 이용한
재성형/재활용 가능 폴리우레탄 개발 필요"

2. Recycling & Remolding Technology of Thermosetting Resins

Development of Poly(thio)urethane & Remolding/Reprocessing Technology Using Only Bio-Based Monomers & Solvents



KRICT Technology: Eco-friendly, Reprocessable Poly(thio)urethane from Bio-Based Sources

	Conventional Technology	KRICT Developed Technology
Bio-Based Monomer	Partial use	Bio-based monomer and solvent
Process Solvent	Toxic organic solvents	Bio-solvent (cyrene) applied
Recycling Efficiency	Low	High

3. Bio-Plastic Manufacturing Technology

1. Development of biodegradable plastic materials as alternatives to single-use plastic bags
3. Pilot testing and public demonstration of bio-plastic prototypes

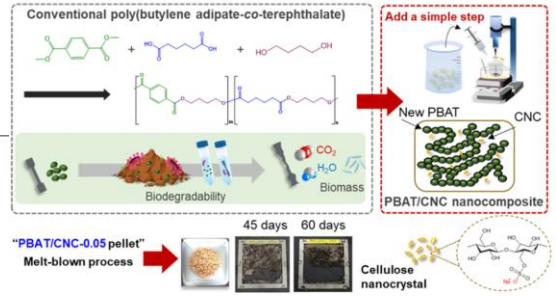
2. Development of ultra-high-strength nanofiber-based composite materials (hydrospongel)
4. Technology for developing eco-friendly composite materials using naturally derived nanofibers

Development of biodegradable plastic materials as alternatives to single-use plastic bags

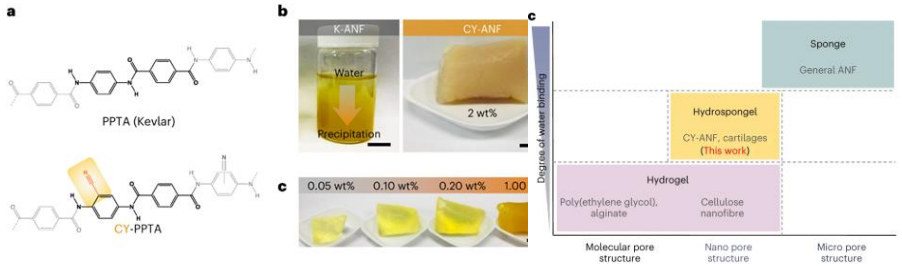
SKC '썩는 플라스틱' 만든다 베트남에 세계 최대 공장 건설

서진우 기자 jwsuh@mk.co.kr
입력 : 2023-09-25 17:44:06

㈜SKC 기술이전
New PBAT 스케일업 > 1 Ton



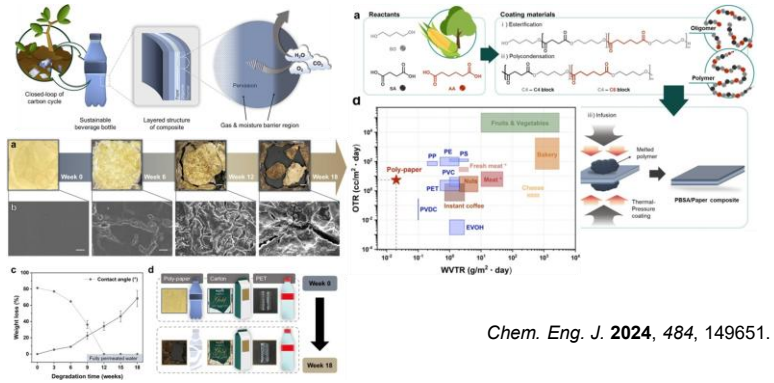
Development of ultra-high-strength nanofiber-based composite materials (hydrospongel)



Nat. Mater. **2024**, 23, 414.

Pilot testing and public demonstration of bio-plastic prototypes

Technology for developing eco-friendly composite materials using naturally derived nanofibers



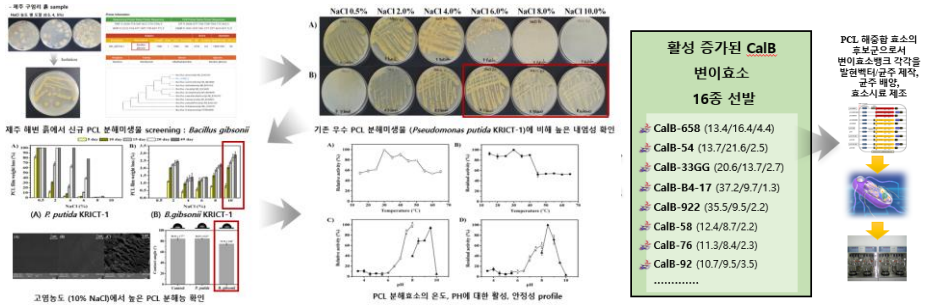
Chem. Eng. J. **2024**, *484*, 149651.

4. Plastic Recycling Technology

1. Securing genetic resources for plastic depolymerization and upcycling
3. Development of bio-based plastic depolymerization and upcycling systems

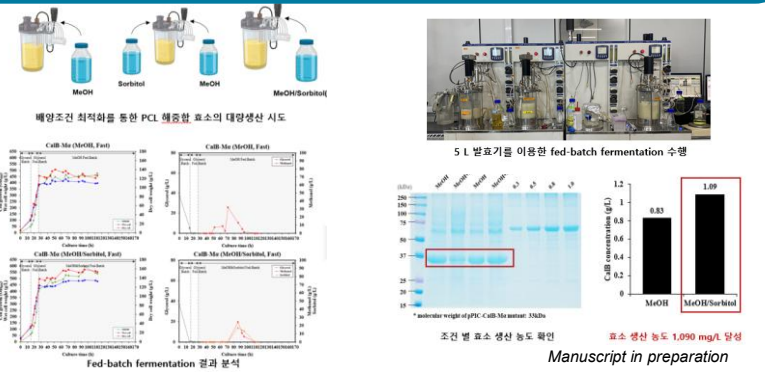
2. Development of microbial/enzyme production systems for plastic depolymerization and upcycling
4. Development of microbe-based alternative materials to plastics

Identification and enhancement of novel microbes/enzymes for plastic depolymerization



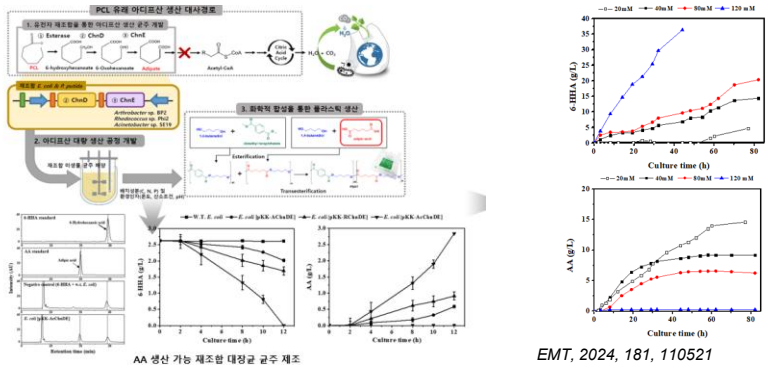
BBE.2024, 29,815-824

Mass production of PCL-depolymerizing enzymes



Manuscript in preparation

Production of adipic acid through a bioprocess system for plastic upcycling



EMT, 2024, 181, 110521

Development of biodegradable plastic materials using microbial mycelium

Manuscript in preparation

5. Biodegradable Plastic Technology Tree

단기(As-Is) 생활편의형 생분해성 플라스틱

2020 | 2021 | 2022 | 2023 | 2024 | 2025

- 바이오매스 기반 단량체 제조기술 확보 및 후보군 발굴
- 단량체 분리/정제 기술 체계화 수립
- 친수성 단량체 고순도 분리/정제기술 개발
- 친수성 단량체의 농도 및 생산성 증진
- 단량체 저가 대량생산을 위한 우량 미생물 균주개발
- PDC, 1,3 PDO 농도, 수율, 생산성 증진
- 생분해성 플라스틱 단량체 공급
- 바이오매스 기반 신규 생분해성 바이오플라스틱 제조연구
- 분해속도 조절 바이오플라스틱 제조기술 연구
- 시범사업 제품 활성화
- 기업과의 실증화 사업 Spin off
- 복합소재 바이오플라스틱 제조연구
- 바이오매스 구성성분 분리/회수 및 기능성 연구
- 셀룰로오스 미세섬유화 및 분말 제어기술 확보
- 폐자원을 통한 나노섬유 및 분산기술 개발
- 자연분해성 미세플라스틱 제조기술 개발
- 플라스틱 해중합 미생물 스크리닝 및 동정
- 고효율 플라스틱 해중합 생촉매 시스템 개발
- 플라스틱 해중합 효소생산 시스템 개발
- 생분해성 미생물 동정 및 퇴비화 생태계 영향평가
- 바이오화학 융합 공정기술 기반 폐플라스틱 분해 및 업사이클링 기술
- 분해/업사이클링 스케일업 공정기술 확보 및 고부가 신규 유용 화합물 발굴 및 제조 기술

중장기(To-be) 산업활용형 생분해성 플라스틱

2026 ~ 2030

바이오화학소재 기술 고도화 및 산업 활성화

폐기물 환경오염 해소

R&D 및 사업화

- 바이오단량체 제조 원천기술 확보 (다종의 플라스틱 단량체 공급)
- 미생물기반 바이오단량체 파이프라인 구축
- 산업형 바이오플라스틱 제품 제작 (생활편의형 제품 제작, 산업용 바이오소재 개발)
- 개발된 생분해성플라스틱의 퇴비화 공정 개발 (공인인증 및 분석 업무 지원 및 활성화)

중장기적 목표

- 난분해성 생활플라스틱 대체소재 개발
- 고물성 산업용 엔지니어링 플라스틱 소재 개발
- 바이오화학산업 활성화
- 자원 재순환을 통한 사회문제 대응
- 퇴비 최적화를 통한 매립지 지원

시장선도형 생분해성 바이오플라스틱 시범사업

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Future Challenges

1. Accelerating the Development of Materials Using Chemical Conversion of Biomass & Waste Plastics

- Scale-up technologies 6 to 15 times larger for commercialization opportunities
- Potential to secure over 50% material conversion rate
- Joint development with related companies, technology transfer commercialization, and linkage to demonstration investment

2. Advancing Biodegradable and Bio-Based Material Technologies & Commercialization

-Cost-effective eco-friendly plastic technologies that degrade well in natural environments
-Development of materials using non-food resources
-Collaboration with companies to develop and commercialize biological technologies using microorganisms and enzymes
-Development of microbe-based alternative materials to replace non-degradable consumer plastics

3. Expanding Collaboration with Other Government-Funded Research Institutes, Universities, Industries, International Organizations & Society

Thank You

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