Global Bio-economy Summit 2018

Bio Chemical Business of Mitsubishi Chemical

19th April 2018

Y. Fujimori
Senior Assistant Director
Division General Manager
Mitsubishi Chemical Corporation
Mitsubishi Chemical Overview

- **Company Name**: Mitsubishi Chemical Corporation
- **Head Office**: 1-1 Marunouchi 1-chome, Chiyoda-ku, Tokyo 100-8251, Japan
  TEL +81-3-6748-7300
- **Date of Foundation**: August 31, 1933
- **Date of Establishment**: April 1, 2017
- **Paid-in Capital**: JPY53.229 billion
- **Representative**: Masayuki Waga, President & CEO
- **Sales revenue**: JPY2,390.9 billion (≒200 MMEUR) (calculated from the simple sum of figures of FY2016)
- **Business Bases**: 4 branch offices, 7 R&D centers, 15 plants, 4 regional headquarters
- **Number of Employees (Consolidated)**: 40,914 (as of March 31, 2017)
A member of MCHC Group

Mitsubishi Chemical Holdings Group*¹

- Consolidated sales revenue IFRS: JPY3,376.1 billion
- Number of employees (consolidated): 69,291

April, 2018

**<Business Domain>**

- Performance Products
- Industrial Materials
- Health Care

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**Mitsubishi Chemical Corp.**

- Sales revenue: JPY2,390.9 billion
- Number of employees (consolidated): 40,914
- Businesses: Performance products, industrial materials etc.

**Mitsubishi Tanabe Pharma Corp.**

- Sales revenue (consolidated): JPY423.9 billion
- Number of employees (consolidated): 7,280
- Businesses: Pharmaceuticals etc.

**Life Science Institute, Inc.**

- Sales revenue (consolidated): JPY133.8 billion
- Number of employees (consolidated): 4,837
- Businesses: Health & medical ICT, advanced medication drug development & manufacturing solutions

**TAIYO NIPPON SANSO CORP.**

- Sales revenue (consolidated): JPY581.5 billion
- Number of employees (consolidated): 15,860
- Businesses: Industrial gases & related equipment / devices etc.

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*¹: Listed
All figures for the fiscal year ended March 2017 (FY2016) [*²: Calculated from the simple sum of figures of FY2016]
THE KAITEKI COMPANY

We have come to believe that what the MCHC Group should aim for is “a sustainable condition which is comfortable for people, society and the Earth, transcending time and generations.” This condition is expressed by our original concept KAITEKI.

“THE KAITEKI COMPANY” defines us as a group in which each member thinks and acts toward the realization of KAITEKI.

With the joint efforts of the MCHC Group, we will create KAITEKI by providing optimum solutions to solving social and environmental issues through our products and services.

Moreover, to share this idea with people around the world, we will take the initiative and act as THE KAITEKI COMPANY.
## Mitsubishi Chemical Corporation

### Organization

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| Teijirou Nishitani            |                           |                           |                           |                             |                   |                     |                     |

| Takashii Miyaki               |               |            |                               |              |        |                  | |

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| Masahiro Yoshikawa                      |                           |                           |                           |                       |                   |                   |                       |                 |                     |                             | |

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| Yousuke Egawa                                |                     |                       |                    |                |                 |                                     |                     |

|----------------------------------------------|-----------------------------------------|---------------------------------------------|------------------------|--------------------------|-----------------------------|-------------------|-----------------| |
| Hitoshi Sasaki                                |                                         |                                              |                        |                          |                             |                   |                 | |

|------------------------------------------------|-----------------------------------------------|-----------------------------------------|-------------------------------|-------------------------|----------------|-------------------------------------|------------------------------------------------| |
| Steve Yurih                                   |                                               |                                         |                               |                         |                |                                     |                                     | |

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| New Energy Strategy & Planning Dept.         |                                 |                  |                     |                     |                                              |              |
Management of Sustainability (MOS)
Management aiming to improve sustainability
Contributing to the resolution of a variety of environmental and social issues through corporate activities that consider the future of people, society, and the Earth

Management of Economics (MOE)
Management which focuses on capital efficiency
Pursuing profits by efficiently using various forms of capital, including human resources, assets and funds

Management of Technology (MOT)
Management which strives to create innovations for society
Creating innovative products and services through the differentiation of technology that we possess

Corporate value = KAITEKI Value

MOS Axis
The value created from MOS

MOE Axis
The value created from MOE

MOT Axis
The value created from MOT

Century

Decade

Quarter

Health Comfort
MOS index

Sustainable

S Index
- S-1: Contribute to reducing the environmental impact
- S-2: Efficient use of resources and energy
- S-3: Contribute to the sustainability of the environment and resources through products and services

Health

H Index
- H-1: Contribute to medical treatment
- H-2: Contribute to the prevention and early detection of diseases
- H-3: Contribute to achieving healthy and hygienic lives through products and services

Comfort

C Index
- C-1: Endeavor to earn greater recognition of corporate trust from society
- C-2: Promote communication and work in concert with stakeholders
- C-3: Contribute to achieving a more comfortable living environment and lifestyle

Progress of MOS indexes

bio- and plant- base businesses contribute to the indexes

THE KAITEKI COMPANY
Mitsubishi Chemical Holdings Group
Our Concepts for Bio-business;

Provide society

1. with materials made from renewable resources by efficient and lean production process

2. with chemically unique biomass materials specifically produced from bio-feedstock
Plant base business as an approach to KAITEKI

1. As a mission of chemical industry: substitute for fossil base products
   - Supply of the products prolongs duration of the fossil base resources
   - Simple and efficient process provide advantages in environmental and economic potential

2. As an approach to create high-function products
   - Plant base molecules provide unique functions unreachable by fossil base materials
Portfolio of our bio polymers

PLA

Bio PE

PA610

PTT

Biodegradable polymers

High-function polymers

Bio-PET

PP

PE

PVC

PBAT

Biodegradable

Durable

(Non-degradable)

Plant base

High-function

Petroleum resource base

April, 2018

THE KAITEKI COMPANY
Mitsubishi Chemical Holdings Group
1. As a mission of chemical industry

- Same end products with fossil base (Drop-in)
- More efficient process (less energy)
- Can be economically competitive
a. Plant base building block chemicals

- Established technologies (and related patents) for 1,4 BDO and some other building blocks
- Ongoing R&D for many others
- Willing to collaborate with partners (e.g. licensing)
What is BioPBS?

BioPBS is a plant-base polyester with excellent bio-degradability & unique properties

- The world first plant-base polybutylene succinate (PBS).
- Commercial plant in Thailand at JV with PTTGr started in 2016

BioPBS complies with many certifications like FCN, EU directive, GB9685(CN) and PL(JP)

Marine Degradability
Now under evaluation
Utilization of BioPBS

- Bio based
- Flexibility
- Heat resistance
- Transparency
- Tear strength
- Biodegradability
- Low temp heat
- Flexural modulus
- Tensile elongation

PLA

PBAT

Biobased

Non-biobased

PS

Starch

PET

PBAT

PP

PE

Compound Use

Utilization of BioPBS

PB

April, 2018
b. Plant-based biodegradable plastics

is a plant-based polyester with excellent bio-degradability & unique properties

- The world first plant-base polybutylene succinate (PBS). A monomer, succinic acid is plant base
- 20,000 MT/year commercial plant at JV with PTT started in 2016
- Standout features are excellent biodegradability at ambient temperature and compatibility with various kinds of materials such as natural fibers
Potential of BioPBS™/PLA Compound

Flexural modulus

Tensile Elongation

- PLA
- PS
- Starch
- PET
- PP
- PE

Potential PBS/PLA Compound

Biobased + biodegradable

Non-biodegradable

Biobased + biodegradable

Biobased + biodegradable

PBS Compound
Commercialized worldwide

- Compost bags
- More than 1,000 branches of Café Amazon nationwide
- Multi film
- 2014 European coffee brands
- The biggest cinema movie theater “Major Cineplex” with BioPBS™ popcorn bucket
- US’s franchise restaurant
- Coffee brands in EU & US
- Tea bag
- 2016 Sugar pouch / Hotel amenity
- Straw
- Paper boxes
- Barrier packaging
- Straw Tea bag
- 2017 Cutlery
- Straw Tea bag
- US’s franchise restaurant
- Coffee brands in EU & US
- Sugar pouch / Hotel amenity
Marine Biodegradability

Cellulose

Already commercialized for scrub application
トピックス：旭化成アドバンス向け（ハンドクリーナー用スクラップ）

○顧客：旭化成アドバンス（株）
○用途：業務用ハンドクリーナー（スクラップ材）
○期待数量：30T/y
○スケジュール：18/6月量産試作、18/8月〜量産
○採用ポイント：Bio由来・生分解性

環境にやさしいスクラップハンドクリーナーです。
生分解性を高めるため、特殊なスクラップ材を用意しました。
生分解性と耐熱性を兼ね備えた素材で、環境に優しいです。

植物由来成分を一部使用した生分解性スクラップ材を採用。
BioPLA（バイオポラックス）は、環境に優しい素材で、生分解性が高いです。

皮膚への刺激が少ない化粧品グレード（医薬品医療機器等法）

洗浄力はこれまでのNEWエコサーファーIIと同様に優れています。

採用ポイント：Bio由来・生分解性

爽やかなライトブルーのクリーナー液です。
Current & Target Application of Bio PBS

- Food/non Food bags
- Stand-up pouch (Barrier)
- Coffee bag (Barrier)
- Paper cup / Food box
- Lid
- Cutlery
- 3D Printing
- Agr. Mulch Film
- Coffee capsule
- Fiber; Non Woven, Tea bag
- Auto parts
- Wood board
2. As an approach to new high-function products

- Unique molecular structure of plant base can provide unique functions unreachable by fossil base material
What is BENEBiOL?

BENEBiOL™ is a plant-base polycarbonatediol (PCD)

- We offer a new PCD as element of urethane with characteristic composition integrated plant-base molecules
- 1,000MT/y capacity

BENEBiOL provides unique properties to final products:

**Synthetic / Artificial leather**
- Flexible at low temperature
- Abrasion resistance
- Chemical resistance
- Weather resistance
- Hydrolysis resistance
- High hardness
- High mechanical properties

**Paint / Coating materials**
- TPU
What is DURABIO?

Besides its high transparency and excellent optical properties, DURABIO™ features excellent scratch resistance, weatherability, and impact resistance.

Glucose → Sorbitol → Isosorbide Monomer → Isosorbide Monomer + Co-monomers

MITSUBISHI CHEMICAL
What is DURABIO?

DURABIO™ (Durable + BioPolymer) is a High Performance Transparent Plastic derived from a Plant-based Renewable Resource

DURABIO™ is a High Performance Transparent Plastic derived from a Plant-based Renewable Resource

Isosorbide monomer

DURABIO™ oxygen-containing Alicyclic Polycarbonate Co-polymers

Plant-derived Glucose

Sorbitol

Co-monomers

Oil

Phenol / Acetone

Bisphenol-A (BPA)

BPA-PC Aromatic Polycarbonate

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**DURABIO™** is a transparent plant-base polycarbonate with excellent and well-balanced function as glass substitute

- 5,000 MT/year commercial plant in Japan started in 2012
- Scratch resistance and coloring property provide access to various market, e.g. automobiles
- Unique optical characteristics such as high transparency and low optical distortion are good for highly-functional optical films and transparent products
Performance and applications

Glass Substitution (Weight Saving)

Transparency
Low Birefringence

Flexibility
Stretch Orientation

Weather-resistance (Resources Saving)

UV Resistance

Surface Hardness

DURABIO™

Impact Resistance

Polycarbonate

Bio-based
Flame Retardancy

Paint-free, Coating-free (Reduction of VOC)

Renewable

MITSUBISHI CHEMICAL
Application of DURABIO

Optical (Glass substitution)
- FPD front panels
- Sunglasses
- LED lighting
- Optical films

Scratch Resistance
- Automotive Interior parts
- Cell Phones

UV Stability
- Lighting sheet
- Film-laminated steel sheet
- Noise barrier wall

Biomass
- Cosmetic containers
- E&E housings

April, 2018

MITSUBISHI CHEMICAL
Applications, Automotive
Applications, Automotive
Applications, Optical devices

SHARP and MCC jointly got 10th Bio-plastic Award in 2015
European Patent Office Upholds Validity of Mitsubishi Chemical's Patent on Biomass-based High-quality Polyester

Mitsubishi Chemical Corporation

Mitsubishi Chemical Corporation (MCC; Head office: Chiyoda-ku, Tokyo; President: Hiroaki Ishizuka) today announced that the European Patent Office (EPO) on May 17 issued a notice maintaining the patent owned by MCC (EP1882712B; “the patent”), which is a basic patent for a biomass-based polyester. Several corporations and others had filed notices of opposition to the validity of the patent. However, the EPO largely sided with MCC’s position as to the patent's validity following the oral proceedings on April 15 of this year.
Mitsubishi Chemical Moves toward Cooperation and Licensing of Patent on Biomass-based Polyurethane and Polyester Polyol with External Organizations

Apr. 18, 2017
Mitsubishi Chemical Corporation

Mitsubishi Chemical Corporation (MCC; Head Office: Chiyoda-ku, Tokyo; President and CEO: Hitoshi Ochi) today announced that MCC will move ahead to promote cooperation and licensing of the MCC-owned basic patent (the patent family of WO2011/125720; “the patent”) for polyurethane and polyester polyol (“the products”), with external organizations.

This basic patent is broadly applicable for business activities such as manufacturing and sales of the products. The patent has been granted in Japan. The corresponding patents have been granted in the U.S., Korea, and China, and MCC has also filed patent applications in other countries.

MCC will move actively to promote the spread of biomass-based products and to expand its own business, through cooperation and licensing with final consumer products makers as well as product manufacturing and sales companies, and contribute to global environmental sustainability. At the same time, MCC will take every appropriate action to defend its patent from any infringements.
For the Expansion of Bio-materials
For the Expansion of Bio-materials

1. Regulation, Social Recognition – Oriented

2. Discovery of Special Characteristics, Usage - Oriented

From both side of these concepts above, We are willing to expand bio-economy, And ready to co-operate with whom it may concern with our accumulated know-how and technology
Thank you for your kind attention!
For the Expansion of Bio-products

- DURABIOは売れて、PBSは売れないという話
- 特徴・用法の発見、規制、特許ライセンス協業
And more… Potentials of plant factory

is the plant factory system to produce safe and healthy vegetables at any time/places

Growing vegetables for a better world.
Optimum growing environments from Mitsubishi Chemical

Higher space efficiency, no agrichemical application and less contamination

Mitsubishi Chemical offers the system and vegetable products

Advanced application; rapid and low-cost preparation of vaccine using Tobacco plant in plant factory

Tobacco growth → Gene uptake → Vaccine production → Preparation

This process needs only 1 ~ 2 months

first wave: Plant → Cell culture → Egg base

No. of case: vaccine

Time from beginning of pandemic

with medicago
Realizing KAITEKI with plant base businesses

- Many ongoing R&D projects and future plans for innovative products, processes and business models based on plant-base and other bio technologies
- Actively seeking collaboration with partners through licensing, etc.

We promote plant-base businesses in order to contribute to the sustainable development of the society and the earth…realizing KAITEKI
Thank you for your kind attention!