10th Annual World Congress on Industrial Biotechnology

DURABIO™: A Durable Bio-based Isosorbide Polycarbonate

June 18th, 2013

Sustainable Resources Department

MITSUBISHI CHEMICAL CORPORATION
Our organization

Mitsubishi Chemical Holdings Corporation (MCHC)*

* Listed

Figures for consolidated net sales and paid-in capital are for the year ended March 2011.

Mitsubishi Chemical Corporation (MCC)
- Paid-in capital: ¥50.0 billion
- Consolidated net sales: ¥2,019.6 billion
- Group employees: 27,828

Mitsubishi Tanabe Pharma Corporation* (MTPC)
- Paid-in capital: ¥50.0 billion
- Consolidated net sales: ¥409.5 billion
- Group employees: 9,198

Mitsubishi Plastics, Inc. (MPI)
- Paid-in capital: ¥21.5 billion
- Consolidated net sales: ¥382.0 billion
- Group employees: 8,549

Mitsubishi Rayon Co., Ltd. (MRC)
- Paid-in capital: ¥53.2 billion
- Consolidated net sales: ¥478.4 billion
- Group employees: 8,203

The KAITEKI Institute, Inc.

Mitsubishi Chemical Holdings America, Inc.

Mitsubishi Chemical Holdings (Beijing) Co., Ltd.
Our Products

Performance Products
- Electronics related products
- Recording media

Health Care
- Pharmaceuticals
- Diagnostic reagents and instruments
- Clinical testing
- Active pharmaceutical ingredients and intermediates

Industrial Materials
- Neat resins and composites
- Carbon products
- Synthetic fiber materials
- Chemical derivatives
- Basic petrochemicals

Information materials
- Inorganic chemicals
- Food ingredients
- Battery materials
- Fine chemicals
- Polymer processing materials
- Composite materials

Electronics Applications Segment
- Recording media

Designed Materials Segment
- Clinical testing

Chemicals Segment
- Neat resins and composites
- Carbon products
- Synthetic fiber materials
- Chemical derivatives
- Basic petrochemicals

Polymers Segment
- Recording media

MITSUBISHI CHEMICAL CORPORATION
These businesses contribute to sustainability, health, and comfort by drawing on the Group’s core technologies, and we are committed to their rapid commercialization as the drivers of our Innovation Strategy.
Our approach to Sustainable Resources

Three approaches to build up bio-based chemicals & polymers business by leveraging new technologies using Sustainable Resources

1. Sustainable Resources
   - Methanol
   - Ethanol
   - Polyols, etc.
   - Succinic Acid

2. Unused gas

3. Biomass

DURABIO™
Bio-based engineering plastic

GS Pla™
Polybutylene succinate

Current Petrochemical Process

Naphtha Cracker
- C2
- C3
- C4
- BTX

Fraction optimization

Derivatives
- 1,4-BDO
Our approach to Sustainable Resources

Three approaches to build up bio-based chemicals & polymers business by leveraging new technologies using Sustainable Resources

Secure raw materials & related biotechnology through partnership

DURABIO™
Bio-based engineering plastic

GS Pla™
Polybutylene succinate

Current Petrochemical Process

Naphtha Cracker
C2 C3 C4
Fraction optimization
C2 C3 C4
Derivatives
1,4-BDO

Unused gas

Naphtha

1,4-BDO

Secure raw materials & related biotechnology through partnership

Our approach to Sustainable Resources

① Secure raw materials & related biotechnology through partnership

② Through partnership

GS Pla™
Polybutylene succinate

Naphtha Cracker
C2 C3 C4
Fraction optimization
C2 C3 C4
Derivatives
1,4-BDO

Unused gas

Biomass

Methanol
Ethanol
Polyols, etc.
Succinic Acid

Unused gas
What is DURABIO™

Roquette is our partner in isosorbide

Plant-derived Glucose

Sorbitol

Oil

Phenol / Acetone

Bisphenol-A (BPA)

DURABIO™

Isosorbide-based Aliphatic Polycarbonate

MITSUBISHI CHEMICAL

Co-monomers

MITSUBISHI CHEMICAL

Isosorbide monomer
Unique Reactivity & Property of Isosorbide

Reactivity: Phenols > **Isosorbide** > Primary Diol >> Secondary Diol

Acidity of OH = Reactivity (pKa estimated value)

High

Polymer Tg (°C)

Aromatic Phenol (Bis-Phenol A)

Isosorbide (Secondary Diol)

Secondary Diols

Primary Diols

PhOH 9.95
BisA 10.17
ISB 13.55
DEG 14.86
EG 14.96
16HG 15.45
CHDM 15.53
TCDDM 15.56
CHDO 17.27
H-BisA 17.52
DURABIO Comparative General Properties

- Excellent Transparency
- Low Birefringence
- Low Photoelastic coefficient
- Retardant Property
- High Impact Resistance (Puncture Impact)
- Heat Resistance
- Surface Hardness
- Superior UV Resistance
- Bio-based
- Flame Retardance

Comparison of DURABIO, PC, and PMMA:
- DURABIO
- PC
- PMMA
DURABIO™ Potential Market

Target market by DURABIO™’s unique characters

- **BIOMASS**
  - Keyword: Polymer blend

- **Optical Properties**
  - Keyword: Glass Alternative

Front Panel & Optical Sheet for Displays

- **Surface Hardness/Coloring**
  - Keyword: Paint-less

- **UV/Weather Resistance**
  - Keyword: no color change

- **Interior parts & Housing for Automotive & E/E**

- **Exterior & UV emission parts for Outdoor & Lighting**
DURABIO™ Applications

Optical properties (Glass alternatives)
- FPD front panel
- Sunglass
- LED lighting
- Optical film

Surface Hardness (Paint-less)
- Interior parts for automobiles
- Cell phone

UV stability (No Color Change)
- Lighting sheet
- Film-laminated steel sheet
- Noise barrier wall

Biomass
- Cosmetic containers
- E&E housings

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Commercial Plant has started operation

- 300 t/Y Demonstration Plant for DURABIO™ has started operation in 2010.
- The commercial Plant has started the operation in Aug 2012.
In conclusion

- Customers expect chemicals from sustainable resources to have the same quality and competitiveness as conventional petrochemicals.

- “Adding value” is one way to correspond to current cost structure. DURABIO™ has unique properties that allow a “the only one” market.

- Partnerships are essential to achieve “speed to market” and establish solid business foundations.

Thank you