Grace Polyethylene Catalysts

Delivering Value Through Performance

Indian Petrochem – 2019

Yogesh Mishra
14th November 2019

GRACE
Talent | Technology | Trust™
A Global Leader

Built on talent, technology, and trust, Grace is a leading global supplier of specialty chemicals.

Our two industry-leading business segments—Catalysts Technologies and Materials Technologies—provide innovative products, technologies, and services that enhance the products and processes of our customers around the world.

Global Public Company

- 3,900 employees in 30 countries
- Customers in 70 countries
- New York Stock Exchange (GRA)
- Holding more than 800 active U.S. patents
- 25 acquisitions since 2003
- Headquarters: Columbia, Maryland USA
- Founded in 1854
## Our Businesses

<table>
<thead>
<tr>
<th>Catalysts Technologies</th>
<th>Materials Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrochemical and Chemical</td>
<td>Coatings, Consumer/Pharma and Chemical Process</td>
</tr>
<tr>
<td>Refining</td>
<td></td>
</tr>
<tr>
<td>Specialty Catalysts</td>
<td>FCC Catalysts</td>
</tr>
</tbody>
</table>

- Specialty Catalysts
- FCC Catalysts
- Hydroprocessing Catalysts (ART)
- Silica-based and Silica-Alumina-based Materials
Grace Provides Partnership, Not Just Products

Working Closely with Customers to Improve Their Products and Processes

- Our customers inspire our innovation. We tailor our products to meet unique customer performance needs.
- We gain deep understanding of our customers’ manufacturing processes and formulations.
- Close collaboration with our customers enables quick adjustments to changing market demands.
- We are constantly researching and developing new products in anticipation of future market needs.
- We invest in R&D and regional support teams to address local customer requirements.
- Our multi-tiered local technical service is backed by central R&D centers.
Core Material Science Expertise

Grace technology is built on a strong foundation of material science expertise, process capabilities, and shared assets that create synergies throughout our businesses and the ability to scale up and produce tailored solutions to meet specific customer requirements.
Catalysts Technologies | Specialty Catalysts

Delivering Value

- Customer-focused, solutions-oriented approach
- Broad, highly-differentiated portfolio of products
- Ability to develop and optimize catalyst properties to specific applications
- Flexible assets for the scale-up and production of commercial catalysts
- Wide range of analytical tools and testing for product and process improvements

Key Customers

- Global petrochemical companies
- National (state-owned) petrochemical companies
- Plastic resin producers

POLYOLEFIN Catalysts

- Polyethylene (PE) catalysts
- Polypropylene (PP) catalysts
- Catalyst supports
- Components

Catalyst performance is a combination of design, characterization, and manufacturing

• Catalysts and supports
• Hydrogenation catalysts
• Technologies for alternative and traditional feedstock

UNIPOL® Proprietary Gas Phase Polypropylene Process Technology

• Simple to build, operate, and maintain

Chemical Catalysts

Process Licensing
Safety and Sustainability are Top Priorities

Across the supply chain, Grace is transparent and trustworthy, assuring customers, employees, and investors that Grace is committed to safety, security, and sustainability.

Audited and certified by the American Chemistry Council, the industry’s Corporate Social Responsibility gold standard.*

**Safety**
- Operating all facilities in a safe, healthy, environmentally sound, and secure manner
- In compliance with local, state, and federal regulations
- Extending the ACC’s Responsible Care commitment to our global facilities
- Manufacturing productivity tools drive reductions in variability and reduce raw material inputs
- Below-average injury rates – millions of working hours without incident

**Sustainability**
- Reducing our impact through:
  - Increased recycling
  - Energy savings
  - Waste reduction
  - LEED-certified headquarters
- 2018 Ecovadis Silver Rating for Corporate Social Responsibility
  - Attentive to customers’ CSR goals
  - In top 10% of all global suppliers assessed on a variety of CSR standards
  - Sustainable practices across the supply chain
  - Recognized for fair labor and business practices
  - High scores in environment and labor practices

*Audited and certified member of the American Chemistry Council’s Responsible Care® Initiative. Signatory of the Global Responsible Care Charter.
Gas Phase Catalyst Portfolio
Advanced Cr Catalysts - Commercial Experience

Demonstrated smooth transition from ZN to Cr and Incumbent Cr catalyst to Grace Advanced Cr

3-4 times higher activity compared to competitor catalysts - Less resource intensity

Operated in dry and condensed mode operation

Product Mapping
- Blow Molding for 25 to 100 liters
- Large Part Blow Molding – 220 to 1000 liters (UN certification)
- General Purpose Film
- Pipe 80 and target for PE 100 for future development
- Geo Membrane – Blown unit
- Plastic Fuel Tank in progress for accreditation

Proven commercial experience with no operational issues observed
**PE Z/N Catalyst Technologies for Gas Phase**

### Customer Goal

**Target Resins**
- MI
- Density
- Application

### Grace Catalyst Design

**Support**
- Productivity (APS, PSD, SA)
- Polymer particle characteristics
- Feeding
- Strength

**Chemistry / Catalyst Recipe**
- Hexene response
- Hydrogen response

**Donor**
- Narrows MWD
- Controls Wax
- Responses

### Commercial Catalyst Solution

**Slurry Loop**
- SYLOPOL® 5951
- SYLOPOL® 5917
- LYNX® 200 series

**Gas Phase**
- SYLOPOL® 53THC
- SYLOPOL® 5800 series

**CSTR**
- SYLOPOL® 5912
- SYLOPOL® 5548
- LYNX® 200 series

### Operating Variables

1. Process Technology
2. Productivity (Economics)
3. Good feeding
4. Low build up
5. Hydrogen Response
6. Comonomer Response

### Catalyst Data

<table>
<thead>
<tr>
<th>Catalyst</th>
<th>Ti (wt%)</th>
<th>Mg (wt%)</th>
<th>Cl (wt%)</th>
<th>Al (wt%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYLOPOL® 53THC</td>
<td>1.5</td>
<td>1.6</td>
<td>10</td>
<td>2</td>
<td>LLDPE to HDPE (Injection Molding)</td>
</tr>
<tr>
<td>SYLOPOL® 5800 series</td>
<td>0.38-0.74</td>
<td>1.4-2.1</td>
<td>6.8-8.6</td>
<td>1.5-2.3</td>
<td>LLDPE (including super hexene) to HDPE (Injection Molding)</td>
</tr>
</tbody>
</table>
# Introducing ActivCat® catalyst technology

<table>
<thead>
<tr>
<th>Cleaner</th>
<th>Versatility</th>
<th>Sustainable</th>
</tr>
</thead>
</table>
| Less chemicals in PE  
Less catalyst residuals  
Improved taste and odor | Works with broad range of metallocenes and supports  
No re-qualifications needed | Lower catalyst consumption from very high productivity - Less resource intensity |
| Cleaner | Lighter | Toolbox |
| High transparency from homogeneous comonomer distribution | High toughness products enable downgauging | Broad LLDPE product capability and MDPE possible |
ActivCat® for mPE

Relative activity

Lower catalyst consumption from very high productivity - Less resource intensity
ActivCat® catalyst for mPE

Broad product range

Enables higher density mPE due to improved productivity

- 80°C, 150psi ethylene pressure, 0.05mg catalyst, 5umol TIBA, 1Hr
ActivCat® catalyst for mPE

High versatility

Works with most metallocenes – enables use of low productivity metallocenes
LYNX® PE Catalysts for Slurry Processes
PE Z/N Catalyst Technologies for Slurry Phase

**Customer Goal**

**Target Resins**
- MI
- Density
- Application

**Operating Variables**
1. Process Technology
2. Productivity (Economics)
3. Good feeding
4. Low build up
5. Hydrogen Response
6. Comonomer Response

**Grace Catalyst Design**

**Support**
- Productivity (APS, PSD, SA)
- Polymer particle characteristics
- Feeding
- Strength

**Chemistry / Catalyst Recipe**
- Hexene response
- Hydrogen response

**Donor**
- Narrows MWD
- Controls Wax
- Responses

**Commercial Catalyst Solution**

**Slurry Loop**
- SYLOPOL® 5951
- SYLOPOL® 5917
- LYNX® 200 series

**Gas Phase**
- SYLOPOL® 53THC
- SYLOPOL® 5800 series

**CSTR**
- SYLOPOL® 5912
- SYLOPOL® 5548
- LYNX® 200 series
Grace LYNX® PE catalyst technologies are designed for use in slurry PE processes

- Slurry CSTR (e.g. Hostalen)
- Slurry loop (e.g. Innovene™ S)

Commercially proven to make:

- Bi-modal HDPE (i.e. pipe, film, small blow molding)
- UHMWPE
LYNX® PE Catalyst Technology Development

- **2001**: Initial Development and Scale-up
- **2002**: LYNX® 200 Commercialization
- **2004-06**: LYNX® 200HAH R&D / Scale-up
  - Commercialization
- **2017-19**: LYNX® 206 / 106 R&D / Scale-up
  - Commercialization

**LYNX® PE Technology**

<table>
<thead>
<tr>
<th>LYNX® PE Technology</th>
<th>Catalyst d50 (micron)</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>10 – 14</td>
<td>base</td>
</tr>
<tr>
<td>200HAH</td>
<td>10 – 14</td>
<td>higher activity, higher H2 response</td>
</tr>
<tr>
<td>206 / 106</td>
<td>5 – 8</td>
<td>better morphology</td>
</tr>
</tbody>
</table>
LYNX® 206 Catalyst Morphology

- No fines, no agglomerates
- Narrow span / globular / monodisperse
- Good replication without fragmentation
- No pre-polymerization needed
- No refrigeration needed for transport / storage
LYNX® 206 Resin Morphology

Cut resin particle showing solid interior
LYNX® PE Catalyst Technology

Lower catalyst consumption
Less handling & stock
Lower catalyst residuals

Less complexity of supply
Improved batch consistency
No hazardous disposal

Make PE100 resins with
long life, light weight, easy
installation for drinking water

Excellent morphology
Higher production rate
Less fouling & downtime

High toughness bi-modal
Premium products
Enable downgauging

Broad application coverage
Pipe, Film, BM, IM

Drop-in technology with enhanced productivity
LYNX® PE Catalyst Technology Highlights

**Good history of commercialization**
- 20 year commercial track record with several upgrades

**Broad process / application coverage**
- Suitable for Hostalen™, Mitsui CX, Innovene™ S
- One-catalyst to make pipe, HDPE film, and small blow molding
- Capable of making UHMWPE

**Excellent performance**
- Fast throughput
- Better catalyst activity
- Good PE resin powder morphology without pre-poly
- Easy to handle as a “drop-in”
Grace Polyethylene Catalyst Portfolio

Broad Portfolio to meet customer needs

- Extensive set of products across Cr, Z/N, and metallocene
- Capability to produce range of resins from LLDPE to HDPE
- High productivity, high performance products

- Long history of innovative catalyst products
- Reliable performance
- Strong technical service support
Thank You!

For more information, please contact:

Yogesh Mishra | yogesh.mishra@grace.com
Disclaimer

Statement Regarding Safe Harbor For Forward-Looking Statements

This presentation contains forward-looking statements, that is, information related to future, not past, events. Such statements generally include the words “believes,” “plans,” “intends,” “targets,” “will,” “expects,” “suggests,” “anticipates,” “outlook,” “continues,” or similar expressions. Forward-looking statements include, without limitation, expected financial positions; results of operations; cash flows; financing plans; business strategy; operating plans; capital and other expenditures; competitive positions; growth opportunities for existing products; benefits from new technology and cost reduction initiatives, plans and objectives; and markets for securities. For these statements, Grace claims the protections of the safe harbor for forward-looking statements contained in Section 27A of the Securities Act and Section 21E of the Exchange Act. Like other businesses, Grace is subject to risks and uncertainties that could cause its actual results to differ materially from its projections or that could cause other forward-looking statements to prove incorrect. Factors that could cause actual results to differ materially from those contained in the forward-looking statements include, without limitation: risks related to foreign operations, especially in emerging regions; the cost and availability of raw materials and energy; the effectiveness of its research and development and growth investments; acquisitions and divestitures of assets and gains and losses from dispositions; developments affecting Grace’s outstanding indebtedness; developments affecting Grace’s funded and unfunded pension obligations; its legal and environmental proceedings; uncertainties related to Grace’s ability to realize the anticipated benefits of the separation transaction; the inability to establish or maintain certain business relationships and relationships with customers and suppliers or the inability to retain key personnel; costs of compliance with environmental regulation; and those additional factors set forth in Grace’s most recent Annual Report on Form 10-K, quarterly report on Form 10-Q and current reports on Form 8-K, which have been filed with the Securities and Exchange Commission and are readily available on the Internet at www.sec.gov. Reported results should not be considered as an indication of future performance. Readers are cautioned not to place undue reliance on Grace’s projections and forward-looking statements, which speak only as the date thereof. Grace undertakes no obligation to publicly release any revision to the projections and forward-looking statements contained in this announcement, or to update them to reflect events or circumstances occurring after the date of this presentation.

Non-GAAP Financial Terms

In this presentation, Grace presents financial information in accordance with U.S. generally accepted accounting principles (U.S. GAAP), as well as the non-GAAP financial information described in the Appendix. Grace believes that this non-GAAP financial information provides useful supplemental information about the performance of its businesses, improves period-to-period comparability and provides clarity on the information management uses to evaluate the performance of its businesses. In the Appendix, Grace has provided reconciliations of these non-GAAP financial measures to the most directly comparable financial measure calculated and presented in accordance with U.S. GAAP. These non-GAAP financial measures should not be considered as a substitute for financial measures calculated in accordance with U.S. GAAP, and the financial results calculated in accordance with U.S. GAAP and reconciliations from those results should be evaluated carefully.

Trademarks

GRACE®, ACHIEVE®, MIDAS® GOLD, MAGNAPORE®, CONSISTA®, SmART Catalyst System® (Stylized), SYLOID®, SYLOBLOC®, LUDOX®, SYLOBEAD®, CBA®, ADVA®, HEA2®, DCI®, are trademarks, registered in the United States and/or other countries, of W. R. Grace & Co.-Conn. TALENT | TECHNOLOGY | TRUST™ is a trademark of W. R. Grace & Co.-Conn.

UNIPOL® is a trademark of The Dow Chemical Company or an affiliated company of Dow. W. R. Grace & Co.-Conn. and/or its affiliates are licensed to use the UNIPOL trademark in the area of polypropylene.

SIX SIGMA® is a trademark, registered in the United States and/or other countries, of Motorola, Inc.

This trademark list has been compiled using available published information as of the publication date of this presentation and may not accurately reflect current trademark ownership or status. © Copyright 2019 W. R. Grace & Co.-Conn. All rights reserved.