PP Polymer Technology Development and Product Development

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• Evolution of PP Technologies
• Sustainable Development
• PP Product Evolutions
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The History of PP

1950  Montecatini starts R&D on polyolefins at the Ferrara Center

1954  Giulio Natta develops a new PP catalyst

1957  First world-wide PP commercial plant at Ferrara
Catalyst Evolution

Increase of catalyst performance

- **Catalyst yield**
  - 2 - 4 Kg/g catalyst  →  100 kg/g catalyst

- **Increase of stereo control**
  - Highly amorphous  →  high stereo control
    - 60 % isotactic  →  99 % isotactic

- **Morphology control**
  - Flake like catalyst  →  high morphology control

Technology Evolution

Increase in Technology capabilities from ....

... simple plants in solution to
Montecatini technology

... highly productive bulk plants to
Spheripol technology

... highly versatile multi-reactor processes in gas phase
Spherizone Technology
Most Widely Used PP Process - *Spheripol*

- Propolymerisation of Catalyst
- Spheripol Loops in liquid phase
- GPR 1

Most Innovative PP Process - *Spherizone*

- Propolymerisation of Catalyst
- Spherizone Loop in gas phase
- GPR 1

**Notes:**
- Monomer 1
- Monomer 2
- Steamer
- Dryer
- Extrusion
Multi-Zone-Circulating-Reactor (MZCR)

- Barrier separates “RISER” and “DOWNER”
  - Polymer is progressing through the 2 “ZONES” of the reactor
  - “Zones” can be different in H2 or co-monomer concentration

Cascade vs. Spherizone Process

Classical staged process

$\tau_1 \neq \tau_2$

Spherizone process

$\tau_{p1} = \tau_{p2}$

Residence time distribution related non-homogeneity

Residence time distribution does not have an influence on homogeneity.
Summary

• The PP Technology had been undergoing a rapid development in the last 60 years making PP to becoming ….
  – A mass product with
  – Affordable price and
  – Ever expanding product properties

WHY ?
Because it has proven to positively contribute to

SUSTAINABLE GROWTH
Sustainable Development

Sustainability ...

... means conserving natural resources and energy and protecting the environment while allowing economic and social progress

... means meeting the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainability

- Standard of Living
- Education
- Community
- Equal opportunities

University of Michigan
“Sustainability Assessment” (2002)
Sustainability Pyramid

How Can Plastics Help in Sustainability?

British Plastics Federation
Weight Reduction Example: Coffee Packaging (50t)

*Calculation: courtesy of Mr. Ingo Heberle, Huhtamaki, [http://www.huhtamaki.com](http://www.huhtamaki.com)*

Weight Reduction Example: Airplane

The fuselage of the new Boeing 787 Dreamliner is made from three plastic composite sections. This serves to reduce fuel burn by as much as 20%.
Plastics Changed Our World

Technology Evolution Leading to Product Innovation

**Mobility**
- Weight reduction
- Fuel reduction
- Safety
- Convenience
Technology Evolution Leading to Product Innovation

### Healthcare
- Hygiene
- Product Safety
- Convenience
- Availability

![Healthcare Image]

**Graph**: Polymerica, PPD, LEF, Polyurea, Polyurethane & Other (1).

1. Includes polycarbonates, polyols, COP, ETP, silicone, acrylics, etc.

Source: BCC Research

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### Food Packaging
- Hygiene
- Food protection
- Convenience
- Shelf life expansion
- Waste reduction

![Food Packaging Image]

**Graph**: Sales of Bottled Water (1986-2006).

Source: Beverage Marketing Corporation, as reported in Beverage World, 2007.
Technology Evolution Leading to Product Innovation

**Industrial**
- Safety Protection
- Light weight
- Affordable
- Convenient

Summary - Technology Evolution
HMC Polymers Contribution - Glass Replacement

Glass Replacement – Key Properties

- **New product solutions for food packaging**
  - Non-breakable
  - Excellent optical properties
  - Hot filling and sterilisation capability
  - Light weight

<table>
<thead>
<tr>
<th>Property</th>
<th>Glass</th>
<th>PP</th>
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</thead>
<tbody>
<tr>
<td>Stiffness</td>
<td>+++</td>
<td>O</td>
</tr>
<tr>
<td>Impact resistance</td>
<td>- -</td>
<td>++</td>
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<tr>
<td>Low temp impact</td>
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<td>Food Protection</td>
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Glass Replacement – Product Solutions

Driving forces

- Shelf appearance is maintained
- PP provides the necessary heat resistance
- Lower stiffness is offset by excellent drop impact
- 2nd generation resin significantly improves HAZE and GLOSS

➤ closer to glass

HMC Polymers Contribution - Tin Can Replacement

![Image of can and pouch]
Tin Can Replacement – Key Properties

- New product solutions for food packaging
  - Improved stiffness impact balance
  - Excellent optical properties
  - Hot filling and sterilisation capability
  - Low weight – low material consumption

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Tin Can Replacement – Product Solutions

- Driving forces:
  - Reduction of weight
  - Design
  - Improved optics
  - Shelf appearance is improved
  - PP provides the necessary heat resistance
  - Tin can provides high stiffness, however easy to deform
HMC Polymers Contribution – Innovative Spunbond Resin

- High end spunbond resin for improved hygienic products
  - Excellent spin-ability
  - Low amount of oils and fumes
  - Excellent tenacity
  - Excellent bonding
  - High productivity
  - Non-phthalate catalytic system

Advanced Spunbond Resin

- Driving forces:
  - Improved process-ability
  - Lower denier
  - Higher softness of non-woven fabrics giving improved comfort
HMC Polymers Contribution – Health Care Resins

- **High demanding health care resin**
  - Highly controlled providing product and application safety
  - Availability of all necessary regulatory information
  - Long term consistency of product structure and formulation ensuring product consistency
  - Light weight

Health Care Resins – Product Solutions

- **Driving forces:**
  - Regulatory changes
  - Product safety improvement
  - Productivity increase
  - PP provides the necessary heat resistance to allow sterilisation at significantly higher temperatures
  - Major properties remain unchanged
Outlook into The Future

Super Light PP Foam

Very low density however providing excellent mechanical properties
- Excellent righty
- High impact resistance
- Break resistance
- Very light weight

**Density**: 0.05 g/cm³
HMC – Conclusion

• There is no end in developing new products and product solutions using polypropylene
  – New developments are driven by advances in technology
    • Catalyst technologies
    • PP production technologies

• HMC Polymers will continue focusing on providing innovative solutions by partnering with front runners in the technology field
Thank you for your attention

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