Views and Prospects of the Polycarbonate Industry

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Robert Eller Associates is a 15 year-old global plastics consulting company helping companies analyze technical, marketing and economic implications for their business to facilitate management in strategic decision making.

- Offices in Akron, Ohio (home office), Paris, Shanghai, New Zealand
- Asia: Active in China (60%), India (20%), Middle East (20%)
- 5 Key Focus areas: TPE’s, ETP’s, Automotive, Compounding and Foams
- Multi-client studies:
  - China TPE Market: 2006
  - North America/Europe TPE: 2006
  - Automotive Soft Trim: 2004
  - Automotive Non-wovens: 2004
- Single client studies
- Mergers and acquisitions:
  - Complete management service for small acquisitions
  - Due diligence
  - Technical Advisors
Polycarbonate

- An amorphous thermoplastic that has three critical functional values:
  - Impact
  - Clarity/Transparency
  - Heat Distortion

- Applications require two of these three functional values or be subject to substitution
- Widely used (global demand of nearly 4000 kt)
- 2007 saw exit of GE Plastics and entry of Sabic
## Polycarbonate Resin Manufacturers

<table>
<thead>
<tr>
<th>PC Manufacturer</th>
<th>Plant Locations</th>
<th>Capacity KT/yr</th>
<th>Tradename/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sabic Innovative Plastics</td>
<td>Spain</td>
<td>280</td>
<td>Lexan</td>
</tr>
<tr>
<td></td>
<td>Netherlands</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Japan</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>US</td>
<td>520</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Saudi Arabia</td>
<td>260</td>
<td>Saudi Kayan (2009), Licensed Asahi Technology</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1300</td>
<td></td>
</tr>
<tr>
<td>Bayer</td>
<td>China</td>
<td>200</td>
<td>Makrolon</td>
</tr>
<tr>
<td></td>
<td>Thailand</td>
<td>220</td>
<td>China plant not yet at capacity (2008)</td>
</tr>
<tr>
<td></td>
<td>Belgium</td>
<td>240</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Germany</td>
<td>330</td>
<td></td>
</tr>
<tr>
<td></td>
<td>US</td>
<td>260</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1250</td>
<td></td>
</tr>
<tr>
<td>Teijin</td>
<td>Japan</td>
<td>120</td>
<td>Panlite</td>
</tr>
<tr>
<td></td>
<td>Singapore</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>China</td>
<td>160</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>480</td>
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SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
<table>
<thead>
<tr>
<th>PC Manufacturer</th>
<th>Plant Locations</th>
<th>Capacity (KT/yr)</th>
<th>Tradename/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dow</td>
<td>Texas</td>
<td>84</td>
<td>Calibre</td>
</tr>
<tr>
<td></td>
<td>Germany</td>
<td>134</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Japan</td>
<td>55</td>
<td>JV with Sumitomo</td>
</tr>
<tr>
<td></td>
<td>Korea</td>
<td>150</td>
<td>JV with LG</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>423</td>
<td></td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>Japan</td>
<td>110</td>
<td>Mitsubishi Chemical - Iupilon</td>
</tr>
<tr>
<td>Engineering</td>
<td>Japan</td>
<td>40</td>
<td>Mitsubishi Gas Chemical-Novarex</td>
</tr>
<tr>
<td>Plastics</td>
<td>Thailand</td>
<td>160</td>
<td>JV Iupilon/Novarex</td>
</tr>
<tr>
<td></td>
<td>Korea</td>
<td>110</td>
<td>JV Samyang Advanced Material-Trigex</td>
</tr>
<tr>
<td></td>
<td>China</td>
<td>80</td>
<td>JC MGC/Sinopec (2009)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>420</td>
<td></td>
</tr>
<tr>
<td>Asahi Kasei</td>
<td>Taiwan</td>
<td>150</td>
<td>JV with Chi Mei- Wonderlite</td>
</tr>
<tr>
<td></td>
<td>Russia</td>
<td>65</td>
<td>Licensed OAO Kazanorgsintez</td>
</tr>
<tr>
<td></td>
<td>Iran</td>
<td>25</td>
<td>Licensed NPC (KZPC)</td>
</tr>
<tr>
<td></td>
<td>Korea</td>
<td>65</td>
<td>Licensed Honam Petrochemical</td>
</tr>
<tr>
<td></td>
<td>Korea</td>
<td>65</td>
<td>Licensed Cheil Industries (Samsung)</td>
</tr>
<tr>
<td></td>
<td>Saudi Arabia</td>
<td>(260)</td>
<td>Licensed Saudi Kayan (See Sabic IP)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>305</td>
<td></td>
</tr>
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</table>

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<table>
<thead>
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<th>Plant Locations</th>
<th>Capacity Kt/yr</th>
<th>Tradename/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idemitsu</td>
<td>Japan</td>
<td>47</td>
<td>Tarflon</td>
</tr>
<tr>
<td></td>
<td>Brazil</td>
<td>15</td>
<td>JV with PC Brazil</td>
</tr>
<tr>
<td></td>
<td>Taiwan</td>
<td>175</td>
<td>JV with Formosa</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>237</td>
<td></td>
</tr>
</tbody>
</table>

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
GLOBAL CAPACITY FOR AND CONSUMPTION OF POLYCARBONATE RESINS (2009)

SOURCE: ROBERT ELLER ASSOCIATES. INC
2008 Asia PC Capacity by Countries

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2008
PC Resin Supplier Strategies

- Focused on cost reduction
  - Application development/ R&D resources are reduced
  - Lower cost raw materials
  - Lower cost manufacturing

- Sabic Innovative Plastic:
  - Leverage raw materials
  - Translate application development/ specialty marketing skills into Sabic
  - Grow copolymers/specialty compounds segment of business
  - Will use Saudi Kayan plant as low cost entry into Asia (no real Asia manufacturing capabilities)?
  - What will Sabic do in China (Petrochina jv plant canceled)?
  - Focused in Asia on high end of market (exporters) due to high manufacturing costs from North American and European plants

- Bayer: Well positioned globally and in particular, with Thailand and Shanghai Asian plants
- Dow: Asset light JV with PIK
- Asahi Kasei: licensing technology rather than marketing resin
- Idemitsu, Teijin, MEP: following Asian strategies
- Only one western company left: Bayer Material Science
Polycarbonate Issues

• **Asian plants vs. Western plants**
  – All recent plants in Asia (Korea, China, Taiwan, Singapore…..Saudi Arabia, Russia, Iran)
  – Asian plants have typical on average 20-25% less variable manufacturing cost than Europe and North America (major cost disadvantage in importing)

• **Raw Materials: Asset light**
  – How to make money?
  – GE/Sabic sale
  – Dow/PIK JV

• **Compounding: shift to specialties**
  – Role of fabricators increasing (simplifying the supply chain)

• **Downstream converting by resin suppliers**
  – Sheet and film

• **Copolymers:**
  – Higher value, less competition?

• **Commoditization:** Is polycarbonate reaching the top of the development cycle?
  – Pricing pressures
  – Compact discs
  – Fewer new applications/resource reductions by resin manufacturers
  – Shift to Asia

• **How do you make money?**
  – Business shift to Asia
  – Low cost manufacturing plants
  – Reduced resources
  – Lower cost raw materials
  – Move to specialties (compounding/copolymers
  – What lessons can be learned from the ABS business
# Global PC Major Market Segments

<table>
<thead>
<tr>
<th>Market Sector</th>
<th>Market Share</th>
<th>Growth Rate (%/yr)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical/Electronics</td>
<td>27</td>
<td>8</td>
<td>Minimization, high heat drivers particularly as higher power chips are used</td>
</tr>
<tr>
<td>Building &amp; Const.</td>
<td>17</td>
<td>6</td>
<td>Driven by PC sheet in glazing</td>
</tr>
<tr>
<td>Optical Data Storage</td>
<td>15</td>
<td>2</td>
<td>Demand peaking, Teijin major supplier, lowest price segment</td>
</tr>
<tr>
<td>Blends/compounds</td>
<td>13</td>
<td>10</td>
<td>Growth in PC/ABS blends in electronic applications requiring greater heat than ABS</td>
</tr>
<tr>
<td>Automotive</td>
<td>12</td>
<td>8</td>
<td>Glazing will drive growth. Exterior panels, headlamps</td>
</tr>
<tr>
<td>Medical</td>
<td>8</td>
<td>9</td>
<td>Aging demographics/BPA issues?</td>
</tr>
<tr>
<td>Water bottles</td>
<td>3</td>
<td>8</td>
<td>BPA issues?</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Films</td>
<td>1</td>
<td>18</td>
<td>New growing applications</td>
</tr>
</tbody>
</table>
Markets/ Market Issues

• Compact Disc
  – Music CD’s are peaked and slowly decreasing (at about 10-12%/year)
  – Data storage is still growing
  – Competitive technologies: MP3, Blu-ray, Stick storage, higher levels of direct downloading
  – Dominated by Teijin: lowest price sector

• Automotive Glazing
  – Is plasma really needed?
  – Who will step up and build the world scale plant: the Saudis as part of their cluster program?

• Films – rapid growth opportunity

• LCD TV’s
  – Large growth opportunity, Asia focused
  – Light guides, diffusion plate, reflection plate, and housings (blends)
  – Non-halogen FR required

• Asia shift: electronics, electrical, automotive
  – Mobile telephones, laptops, electronic devices, all high growth opportunities in Asia

• SIP: a reinvigorated applications development focus?

• Environmental factors
  – PC in a battle it can win?
aerodynamic styling ......and lightweight
.....and lowers the center of gravity

Photo courtesy Exatec
and allows for parts/system integration…….
Environmental Issues

- It seems every time you turn around some new environmental challenge seems to be facing polycarbonate
  
  - Phosgene vs. Non-phosgene Plants
    - Asahi has become big licenser of non-phosgene technology
    - No longer critical issue: technology is broadly available
  - Halogenated FR vs. Non-halogenated FR
    - A PC advantage?
    - Manageable issue: technology is broadly available
  - BPA
    - Baby bottles, medical and water bottle applications most vulnerable
    - Momentum building despite technical data supporting
    - Emotional driven issue/ Is this a battle that can be won?
Polycarbonate: A 2008 Summary

• An example of a specialty resin being transformed into a commodity?
  – Compounding opens the door to “specialties”
  – Higher value copolymers successful?
  – The risk of entry of a Dow/Chi Mei/Formosa as manufacturers?
• Suppliers struggle with how to achieve profitability?
  – Low Cost Raw Materials
  – Reduce costs (sales, applications and research costs)
  – Lower cost manufacturing sites
  – Specialties including moving downstream into sheet and film
• Markets achieving maturity
  – compact discs
• Major application development opportunity
  – Automotive glazing
• Business in major transition:
  – Shift to Asia/growth of Asia in importance
  – New names/owners
  – The end of the specialty era?
  – The end of application development?
Thank You!

Robert Eller Associates LLC
CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES