Global Trends and Developments in Polyamide Engineering Plastics Applications

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Director

AWJ Consulting
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Where does China fit in?

Tony Jones

Agenda

- Introduction to AWJ Consulting
- Global demand and recent growth in PA Engineering Plastics applications
- Overall 2011 PA demand in China – by PA polymer type and process/end-use market
- Key PA applications and trends in the Automotive Industry
- Key PA applications and developments in the Electrical/Electronic Market
- Major applications for PA in Consumer and Industrial Markets
- PA demand in Film and other extrusions
- Supply leadership in the PA6 and PA66 markets
- The structure of the PA compounding industry in China
- The impact of the fibre market on PA compound production
- Prospects for PA demand growth up to 2020
About AWJ Consulting

• Founded in 2007 by Tony Jones
  – 30 years experience in the Plastics Industry
  – Network of associates to ensure global service capability
• Consulting services entirely dedicated to the Global Engineering
  Thermoplastics Industry
  – Main strategic focus on Polyamide
• Extensive market experience in, and knowledge of:
  – Injection Moulding
  – Thermoplastics Compounding
  – Extrusion
  – Plastics Recycling
  – Automotive plastics applications and component supply
  – Electrical and Electronic markets
• Multi-client studies on the Chinese, Indian, North American and European
  PA markets
• Research and consulting services include acquisition screening and
  appraisal
• See www.awjconsulting.com for more details

Polyamide market organisation and product flow
2011 Global Demand for PA6 and PA66.

Global Demand for PA6 - 1.91 m tonnes
- China: 27%
- Rest of World: 73%

Global Demand for PA66 - 1.18 m tonnes
- China: 23%
- Rest of World: 77%

<table>
<thead>
<tr>
<th>m tonnes</th>
<th>PA6</th>
<th>PA66</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>0.51</td>
<td>0.27</td>
<td>0.78</td>
</tr>
<tr>
<td>Rest of World</td>
<td>1.4</td>
<td>0.91</td>
<td>2.31</td>
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<tr>
<td>Total</td>
<td>1.91</td>
<td>1.18</td>
<td>3.09</td>
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PA Demand Growth in North America, China and Europe 2006 - 2011
### 2011 PA demand in China by process and application

<table>
<thead>
<tr>
<th>Units: 000 tonnes</th>
<th>PA6</th>
<th>PA66</th>
<th>High Temp Nylons</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>Injection moulding</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Automotive</td>
<td>65</td>
<td>85</td>
<td>7</td>
<td>157</td>
</tr>
<tr>
<td>Electrical</td>
<td>159</td>
<td>125</td>
<td>12.7</td>
<td>296.7</td>
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<td>Other industrial markets</td>
<td>158</td>
<td>41</td>
<td>0</td>
<td>199</td>
</tr>
<tr>
<td>Film extrusion</td>
<td>67</td>
<td>3</td>
<td>0</td>
<td>70</td>
</tr>
<tr>
<td>Other extrusion</td>
<td>59</td>
<td>16</td>
<td>0</td>
<td>75</td>
</tr>
<tr>
<td>Blow moulding</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>511</td>
<td>272</td>
<td>19.7</td>
<td>802.7</td>
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</table>

NB: Tonnage volume is the weight of PA polymer or compound used by the processor and includes prime (virgin), secondary and reprocessed compounds.

### Overall 2011 demand (825KT) by PA type

- **PA6 (511KT)**
  - EMS PA 6T/6I
  - DuPont PA 6T/66
  - PA10T/6T

- **PA66 (272KT)**
  - EMS PA 6T/6I
  - DuPont PA 6T
  - DSM PA 4.6

- **HTN (200KT)**
  - EMS PA 6T/6I
  - DuPont PA 6T
  - DSM PA 4.6

- **PA12 (85KT)**
  - EMS PA 6T/6I
  - DuPont PA 6T
  - DSM PA 4.6

- **PA11 (3.5KT)**
  - EMS PA 6T/6I
  - DuPont PA 6T
  - DSM PA 4.6

- **Semi-aromatic PA (6KT)**
  - EMS PA 6T/6I
  - DuPont PA 6T/6I
  - BASF PA 6T
  - Solvay PA MD6
  - Mitsubishi PA MD6
  - Asahi Kasei PA 66/6I

- **Bio-based PA (4KT)**
  - EMS PA 10.10
  - DuPont PA 6.10
  - Evonik PA 6.10
  - Arkema (Hippo) PA 10.10
  - Shandong Dongchen PA 6.10
  - PA 6.12 PA 10.10 PA12.12 DSM PA 4.10
  - Shandong Guangyin PA 6.10
  - PA 6.12, PA 10.12
  - Radici PA 6.10
  - BASF PA 6.10
Sources of growth for PA

- Volume changes in end-use industries
- Migration of foreign PA processing into China
- New applications in end-use industries
- Life-style changes
- Downgauging
- Substitution of traditional materials
- Substitution of other polymers
- Net exports of semi-finished and finished goods – clearly a significant market in China.

% Weight of Different Types of Plastics in a typical Car
Automotive PA applications and trends

- Automotive Industry accounts for about 24% of all PA injection moulding
- Passenger vehicle production up 10% for first 9 months of 2012 (9.74m)
- Light commercial vehicle production up 1% for first 9 months (3.61m)
- Top 3 car producers (FAW VW, Shanghai VW, Shanghai GM) account for 30% of overall output
- Approx 8-10kgs of PA used per car, depending on model
- Powertrain and underbonnet account for about 60% of PA volume
  - intake manifolds, header tanks, filters, fans and shrouds, engine covers

Automotive PA applications

- Exterior /Interior applications account for approx 20%
  - door modules, airbag housings, seat structures, gear shift housings, mirrors, wheel trims
- Electrical /Electronic applications account for 12 -15%
  - switches, cable harnesses, connectors
- Chassis and underbody – account for 5-8%
Automotive PA component supply chain

- Increased modular design and parts integration
  - front ends
  - steering columns
  - filtration, engine covers, and air intake manifolds
  - doors
- Ongoing application developments supported by leading PA suppliers
  - bumper stiffeners, oil pans, structural inserts
- Continued consolidation
  - most parts of PA component supply chain

Electric Vehicle developments

- Very limited development to date of sales of Electric and Hybrid vehicles in China
  - unit sales of just over 8,000 in 2011, almost all to government fleet
- Major investments in Electric and Hybrid vehicle technology
  - government incentives for technology and battery companies to make in China
  - investors include US car producer Coda, and battery producers Boston Power and Power Genix
- Chinese car producers such as SAIC, BYD, and Great Wall developing EVs or Hybrids.
- Future growth of EVs or Hybrids at the expense of petrol (gasoline) engine will reduce kgs/car of PA
Electrical /electronic applications

- PA demand of 296kt for injection moulding in 2011
- Main PA volume applications include:
  - Moulded Case Circuit breakers (MCCB)
  - Terminal blocks
  - Power Tools
  - Cable Ties
  - Connectors

Electrical PA component supply chain

- Chinese low-voltage circuit breaker industry is a relatively mature industry
  - Competitive landscape with many local and multinational manufacturers
  - The top 10 low-voltage circuit breaker producers have a 55-60% market share
  - Schneider and ABB are market leaders with combined 30% market share
  - Chint, Changshu Switch, Siemens, Shanghai Lean and Beijing People important
- Flame retardants playing major role in developing PA growth
- Strongest PA suppliers need to have global capability
- China’s Electrical Products Industry heavily export driven
**Consumer and industrial moulding applications**

- Broad range of applications (50+) - 199 kt demand in 2011
- Segment more fragmented than Automotive and Electrical
- Large number of moulders supplying more localised markets
- Chairs, toys, castors, pumps, furniture, fasteners are significant
- PA growth in segment largely tracks around GDP
- Greater participation of independent compounders
- Significant use of PA compound including reprocessed fibre waste

5-leg chair base  
Approx. 25 kt of PA compound in 2012

**The impact of the PA fibre market**

- Trends in PA fibre market affect compounding industry
- Reprocessing of both fibre production and fibre end-use product waste
- **How much reprocessed PA fibre waste is currently used in the production of PA compounds in China?**  
  - Appears to be no clear authoritative view!  
  Perhaps 3% of PA fibre production is reprocessed  
  A figure of 30-50,000 tonnes p.a. could be reasonable!
**PA film extrusion**

- 70-75,000 tonnes of PA6 film will be produced this year (+10% growth)
- Over 90% is BOPA, with approx. capacity of 90-100kt (21 lines)
- Largest BOPA producers include:
  - Xiamen Changhua, Cangzhou Mingzhu, Tianjin Yuncheng, Foshan, Unilika, and Hyosung
- Brückner key supplier of extruder technology
- DSM, Meida and Sinopec Baling are key PA6 polymer suppliers
- Diverse range of consumer and industrial packaging applications
- Short term PA film market growth should exceed that for PA6 as a whole

**Non-film extrusion markets**

- Chinese PA demand of approximately 75kt in 2011
- Monofilament fishing lines are largest PA6 application (40kt)
- Thermal breaks are largest single PA66 application (15kt+)
  - Technoform and Wuhan Yuanfa are the 2 key manufacturers
  - Short term forecast growth will exceed GDP
- Other PA extrusion includes conduit, tube, wire coating, and semi-finished products

40%GF PA66 Thermal break
Leadership in PA polymer supply

- Meida are market leader in PA6
- Other significant domestic PA6 suppliers include:
  - Sinopec Baling, Huajian Nylon, and Wuxi Chang’an Polymer
- Shenma are the only Chinese PA polymer producer who are also manufacturing compounds (PA66)
- 3 other domestic PA66 producers all actively supply
  - Jiangsu Huayang, Fujian Shiteng and Huafon (since Q2, 2012)
- Major PA6 imports from Li Peng, Zig Sheng, Kuibyshevazot, Honeywell and Formosa
- Main PA66 imports from Invista, Ascend, Rhodia and GPPC

PA compound production of Chinese Companies

- Approx 70 other companies: 62%
- Xingfa: 10%
- Shenma: 2%

Total = 425,000 tonnes
Foreign companies producing PA Compound in China

- BASF, DSM and DuPont all 20kt+ p.a. producers
- Lanxess and Rhodia each produce 10-20kt p.a.
- Radici, Kuibyshevazot and Toray from 5-10kt
- Invista and Ascend have PA66 “toll” compounded
- EMS, Nilit, and Aquafil are other active producers
- Independents compounding in China include:
  - Akro Plastic, Schulman, Polykemi, RTP, Polyone, Ter Hell
- Albis are investing in a compounding plant

PA polymer producers lead European PA compound output

![Graph showing PA6 and PA66 compound output](image)
Summary

- China PA ETP market should grow at 6-8% p.a. in short term
- Automotive market will see highest level of growth
- China likely to command 30% of global PA market by 2016
- Leading global ETP producers will continue to grow and strengthen their supply capabilities in China

Questions?

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