THE TPE INDUSTRY: MATURITY, GROWTH, AND REGIONAL DYNAMICS

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PREPARED FOR:
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OBJECTIVES

- Global/regional dynamics and economics as they affect TPEs
- Technical, economic, trends
- Pricing trends and dynamics
- Intermaterials opportunities and threats
- Implications of maturing markets
- Some new normals
REGIONAL ECONOMICS SNAPSHOT

• Europe:
  - Emerging from economic slowdown, southern Europe worst

• N. America
  - Fastest recovery region (auto, construction, medical)

• China:
  - Slowdown to 7.5%/yr growth; will overtake U.S.; middle income trap

• Brazil:
  - Slowing after boom years, strong auto sector

• Mexico:
  - Boom years will continue to stimulate TPE market

• Turkey:
  - GDP = $800BN
  - 2 TPE compounders (exporting to Europe [30% of exports], entering U.S.
    - Strong global expansion
  - Overseas construction focus (esp. Middle East)

• India:
  - High interest rates slowing growth slightly, GDP growth down
  - Recent rupee value loss (18% in 2013), slows imports
  - Still a low cost compounding region
  - Investment opportunity?
ECONOMIC SLOWDOWNS AND SHIFTS WILL AFFECT GLOBAL TPE DEMAND

<table>
<thead>
<tr>
<th>REGION</th>
<th>GDP GROWTH, %/yr</th>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2013</td>
<td>2010</td>
</tr>
</tbody>
</table>
| CHINA    | 7.8   | 10.0  | Moving:                                                                               
|          |       |       | - Beyond reverse engineering → technology innovation via R/D                                                                               |
|          |       |       | - Toward increased private consumption; away from cheap labor                                                                            |
| INDIA    | 5.6   | 8.8   | - Lagging in education, health care, infrastructure investment                                                                     |
|          |       |       | - Young population. Emerging center for compact auto production                                                                       |
|          |       |       | - 18% decline of rupee (YTD 2013)                                                                                                      |
| TURKEY   | 0.3   | 9.0   | - Rising interest rates will constrain consumer demand                                                                               |
|          |       |       | - Dollar loans represent 22% of overall economy                                                                                         |
| BRAZIL   | 2.5   | 7.5   | Commodity prices collapse, large dollar loans hurt economy                                                                              |
| JAPAN    | 2.0   | -0.5  | Increased shift to offshore auto production                                                                                            |
| USA      | 1.7   | 4.0   | Recent dollar weakening. Monetary policy shift → global effects                                                                       |
| EUROZONE | 0.3   | 2.0   | Recession ended in 2Q/13, expected growth = 1.2% in 2014                                                                               |

Data sources: IMF 072413; EUROSTAT

U.S. monetary policy shifts will dampen emerging market:
- GDP growth
- foreign investment
- currency values, BUT
- stimulate exports

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
Passing the Baton

Contribution to global GDP growth, in percentage points

Developed world: 2.01
Emerging world: 1.43

Note: Data are through Aug. 7. Source: Bridgewater Associates LP. The Wall Street Journal
REGIONAL GROWTH RATES ARE SHIFTING

The great deceleration

PHOTO SOURCE: THE ECONOMIST
CURRENT/FUTURE CHINA TPE SNAPSHOT

• ECONOMIC POSITION
  - 40% of global growth last 20 years
  - Largest global exporter → slight slowdown in 2013
  - Shift to internal growth potential (consumer products)
  - Largest holder of foreign exchange → private equity presence
  - Only 3 global multi-nationals (>50% of revenues from overseas investment)

• CHINA/ASIA TPE ROLE
  - Major TPE consumer with strong growth potential
  - High growth TPE markets(auto, electronics, medical)
  - PVC replacement, significant TPE driver not as strong as in Europe
  - Largest TPE investment ever (CTS, Hexpol, Wittenburg, Kraton, Lanxess)
  - Recent SEBS resin capacity expansion
  - Asian POE and EPDM investment (China the target)
  - IP concerns for investments
• Markets
  - High growth auto and consumer products market
  - SEBS coated fabrics starting to appear on market
  - Growth of trade with Africa, especially low cost (SEBS intensive) consumer goods

• TPE types
  - o-TPV has often been used in applications for which SEBS compounds used in West (e.g. soft grips). Recently shifting to more typical market allocation
  - o-TPV blends have appeared on the market for haptic (soft touch) applications
  - Commodity applications (tooth brush, pen grips) very price competitive. SBS and SBS/SEBS in use

• TPE compounding presence
  - Tariff barrier protects domestic compounders
  - Free trade agreements with Singapore and Malaysia affect SEBS imports
  - Significant cost advantages vs Western compounders
  - TPE exports starting
EUROPE: RECOVERY STARTING

Source: Bloomberg
EUROPE: RECESSION HAS AFFECTED TPE VOLUME

MAP KEY
- EXTREME RECESSION
- PROLONGED RECESSION
  No growth for at least a year
- RECESSION RISK
  Economy shrank in last reported quarter
- RECOVERING OR STILL GROWING

COUNTRY
2012 annual change in S.D.F.
Most recent unemployment rate

IRELAND
+0.3% 14.2%

BRITAIN
+0.3% 7.6%

NETHERLANDS
+0.2% 7.6%

DENMARK
-0.6% 7.4%

SWEDEN
+0.5% 8.2%

FINLAND
-0.2% 8.4%

ESTONIA
+3.2% 6.9%

LATVIA
+5.6% 14.3%

LITHUANIA
+3.6% 13.1%

IRELAND
+0.3% 14.2%

BELGIUM
+0.2% 8.9%

LUXEMBOURG
+0.3% 9.6%

GERMANY
+0.7% 5.4%

AUSTRIA
+0.9% 4.9%

CZECH REP.
-1.3% 7.2%

HUNGARY
-1.7% 11.2%

POLAND
+1.5% 10.6%

SLOVAKIA
+2.0% 14.6%

SLOVENIA
+0.8% 9.7%

FRANCE
+0.6% 10.4%

ITALY
-2.4% 11.6%

SPAIN
-1.4% 27.5%

PORTUGAL
-1.6% 12.5%

BULGARIA
+0.8% 12.5%

GREECE
-6.4% 27.2%

CYPRUS
-2.4% 14%

MAP SOURCE: EUROSTAR
PMI INDEXES INDICATE REGIONAL GROWTH SHIFTS

PMI SOURCE: MARKIT

U.S. resurgence in manufacturing. Suggests re-shoring

Germany fast recovery but not expanding. UK expansion

Emerging regions (BRICS) losing manufacturing growth lead. Still relatively high GDP growth vs West

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
World’s biggest economy, 2025 - 2030
Room for very high growth, despite recent minor slowdown to 7.5 - 8.0% and shift of some industries to other Asian regions
Major Industrial development likely
World class companies still developing
Remains key target for SEBS compounders
Multiple quality levels

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
- China wages: CAGR (18%/yr)
- Foreign direct investment, China still the global leader: $120BN in 2012 (down 3.7% from 2011)
- China exports slowing but still double digit growth
- Auto exports from China (GM targeting 100,000 exported vehicles in 2013, Honda exports)

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
- Global auto production growth = ~12%/yr thru 2020
- India pass car growth (2011-2020): 3 → 6-9 MM units
- India + China could represent growth potential (‘11 – ‘20) of 20MM vehicles ~ 50kT at current o-TPV and SEBS compound utilization rates

EUROPEAN CAR SALES DECLINE WILL AFFECT TPE DEMAND

- Decline in consumer appetite for cars
- Rebound to only 14.7 MM vehicles by 2020, 8% lower than 2007 peak
- German production up 14% in Sept/’13, export driven
- % of Europeans of driving age is growing more slowly than in other regions
- Aging population
- Growth of car-sharing services
- Excellent non-auto transport system
- Some pent-up demand (average vehicle age is 8.5 years vs 11 years in U.S.)

DATA SOURCE: IHS

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
OVERCAPACITY IN SOME ASIAN TPE SECTORS:
EXAMPLE SEBS RESIN

SEBS RESIN CAPACITY IN CHINA/TAIWAN (2015)

ANNUAL CAPACITY, kT

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
PRICE PRESSURES ON TPEs - UPWARD

CURRENT PRICES

UPWARD PRICE PRESSURES

GRADE MIX - SPECIALTIES

MARKETS - HIGHER PERFORMANCE MARKETS
- CONTINUED GROWTH OF AUTOMOTIVE MARKETS.

SUPPLIER STRATEGIES
- DE-EMPHASIZE COMMODITY MARKET SECTORS(a)

RAW MAT’L - BUTADIENE PRICES (SEBS)

Note: (a) High end TPE suppliers

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
PRICE PRESSURES ON TPEs - DOWNWARD

CURRENT PRICES

DOWNWARD PRICE PRESSURES

MARKETS
- MATURING COMMODITY MARKET SECTORS
- SLOWING BRICs GROWTH

COMPETING MAT’LS.
- OBC
- POEs
- EPDM(d)

TECHNOLOGY
- PROLIFERATION

INDUSTRY STRUCTURE
- NEW ENTRANTS (a)
- NEW REGIONAL COMPOUNDERS

REGIONAL SHIFTS
- SHIFTED BRIC MARKETS
- SHIFT TO LOWER QUALITY/PRICE TIERS (b)
- GENERALLY LOWER PRICED MARKETS
- CHINA PRICING MODEL (c)

MACRO ECONOMICS
- SOFT GLOBAL ECONOMY
- EMERGING REGIONS SLOWING

RAW MAT’LS COSTS
- SEBS OVERCAP’Y
- EPDM OVERCAP’Y

RAW TEXT:

(a) Asian suppliers entering Western markets
(b) e.g. Global, glocal, local, bottom end
(c) e.g. Cash flow vs. return on capital pricing model
(d) EPDM is in global overcapacity

ROBERT ELLER ASSOCIATES LLC, 2013
<table>
<thead>
<tr>
<th>QUALITY TIER</th>
<th>TPE PRICES</th>
<th>KEY PRICE DETERMINANT</th>
</tr>
</thead>
</table>
| Global       | Major suppliers able to command premium | - Driven by global specifications  
- Extensive “library” of applications history  
- Domestic Asian TPE suppliers unable to compete (some exceptions)  
- Willing to assume warrantee responsibility  
- Ability to innovate new applications |
| Glocal       | - Global and glocal prices converging  
- Currently price battleground between global and glocal suppliers. | Global suppliers adapting to local conditions:  
- Equipment selection  
- Raw materials choice  
- Re-branding of global brands  
- Limited quality testing  
- Reduced tech service support  
- Limited/ no warranty responsibility |
| Local        | Local pricing | Local quality |
| Bottom end   | Lowest       | - Quality unacceptable to higher tiers  
- Lowest quality raw materials  
- Price based competition  
- Local marketing channels |
TPE GROWTH DYNAMICS: TECHNOLOGY PUSH/MARKET PULL

TECHNOLOGY PUSH
- HEAT RESIST
- ADHESION
- SCRATCH RESIST
- FOAMING
- CONDUCTIVE
- HMS (SBCs)
- NEW PROCESSES (a)

MARKET PULL
- ANTI-PVC PRESSURES
- AUTO DRIVERS:
- WEIGHT/COST SAVE
- LUXURY
- GLOBAL SUPPLY
- SUSTAINABILITY
- PRODUCT INNOVATION

BARRIERS

- Entrenched incumbent technology
- Slow adaptation in emerging markets
- Incumbent /competitor cost advantage (e.g. PVC, OBC, POEs)
- In-house rubber compounding
- Shift to commodity strategy by major TPE suppliers

(a) e.g. foaming of TPU (BASF process), core-back processes, slush molded SEBS

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
TPE MARKET TRENDS

• Comoditization:
  - Segments into specialties and commodities with associated concentration by TPE suppliers
  - Back integration by distributors into compounding (e.g. Alibis, Ravago, PTS, Alliance)

• Demand growth in non-China/non-India emerging markets:
  - Middle class empowerment
  - Growth of auto demand (e.g. Indonesia)

EXAMPLE TPE GROWTH MARKETS

<table>
<thead>
<tr>
<th>TPE TYPE</th>
<th>MARKET</th>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEBS</td>
<td>Packaging</td>
<td>Soft touch labels, caps</td>
</tr>
<tr>
<td>SEBS</td>
<td>Auto</td>
<td>Skins, body/glazing seals</td>
</tr>
<tr>
<td>SEBS, COPE</td>
<td>Electronics</td>
<td>Silky feel, Challenge TPSiV</td>
</tr>
<tr>
<td>o-TPV</td>
<td>Auto</td>
<td>Body/glazing seals</td>
</tr>
<tr>
<td>SEBS</td>
<td>Medical</td>
<td>Films, tubing. High growth sector</td>
</tr>
<tr>
<td>SEBS</td>
<td>Wire/cable</td>
<td>Must compete with f-PPO</td>
</tr>
<tr>
<td>Bio – TPU, SEBS, COPE</td>
<td>Several</td>
<td>Multiple approaches to bio-TPEs</td>
</tr>
<tr>
<td>TPU foam</td>
<td>Footwear</td>
<td>BASF process. Application to other markets</td>
</tr>
</tbody>
</table>

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
**TPEs IN WINDOW ENCAPSULATION**

- **Application:** Rear quarter window encapsulation seal

- **TPE Candidates:** o-TPV, SEBS

- **Incumbents:** PUR, PVC, EPDM

- **Key Properties:**
  - High flow (to reduce breakage)
  - Glass adhesion
  - UV/weather resistance
  - Low compression set
  - Squeak resistance
  - Scratch resistance

- **Notes:** Example of intense inter-material competition
  - Static seal application
  - Two shot adds value
  - Colors?
  - Narrower profiles?
  - Systems cost save opportunities
  - Polycarbonate glazing could shift requirements

*Photo Source: Kraiburg*

*Photo Source: Robert Eller Associates LLC*
UNDER HOOD TEMPERATURE INCREASES ➔ HIGH HEAT TPEs

- **Application:** Air duct cuff
- **TPE type:** s-TPV (Zeotherm® TPV)
- **Key properties:** Heat resistance, Ease of processing, Polyamide adhesion

Note: Example of metal replacement (e.g. polyamide) pulling TPEs into under-hood applications

- **Application:** Hot air duct (primarily turbo engines)
- **TPE type:** s-TPV (Zeotherm® TPV)
- **Key properties:** Heat resistance, Processing ease
- **Process:** Blow molding

Source: Zeon Chemicals

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
AUTO SHORT AIR DUCTS: MODERATE TEMP. UNDERHOOD APPLICATION

• Application: Short clean air duct

• TPE Candidates: o-TPV, PVC/NBR

• Rubber competition: EPDM

• Key Properties:
  - Constant temp resistance to 135°C
  - Oil resistance
  - 75A hardness

• Fabrication process: Injection or blow mold

• Notes:
  - Recent example (not shown) is Hyundai short air duct based on Santoprene™ TPV
  - s-TPVs and COPE for higher temp ducts
  - Weight and cost save vs TS rubbers
  - Recyclability a benefit of TPE use

Photo source: ExxonMobil
• Packaging (grips, cap liners, soft touch) is SEBS (and SBS) growth sector

• Medical, consumer, sports drinks, cosmetics

• Drivers: Soft touch, colorability, adequate compression set, substrate adhesion, two shot

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
TECHNICAL TRENDS AFFECTING SEBS COMPOUNDS

• Improved SEBS grades
  - Slush moldable SEBS
  - Coated fabric grades (already advanced in China, starting in India)
  - Continued evolution of two-shot molding for larger parts
  - Medical grades, especially for IV bag film (3 layer PP/SEBS competes with 5-layer PP/PET/POE/tie layer approach from Sealed Air)
  - LSOH grades; wet grip; Shape retention/recovery

• Competition from improved PVC grades to answer SEBS challenge

• Bio-elastomers

• Continued growth of multi-component technology
  - Overmolding/2-shot and extension to foaming methods
  - Co-extrusion (especially in medical bag applications)
  - Co-blow molding
  - Profiles

• Evolution of soft touch: silky feel odor control, anti-microbial, wet grip

• Commodity Chinese resin suppliers catching up in quality and versatility
AUTOMOTIVE: KEY TARGET MARKET FOR TPEs

BUMPER FASCIA
TPO STILL DOMINATES, (SBC MODIFIER)

UNDERHOOD (INCLUDING SHORT DUCTS)
- s-TPV
- COPE

IP SKINS
- TPO RESURGING
- SEBS SLUSH, o-TPV
- COPE

BODY/GLAZING SEALS
- o-TPV
- HI MELT STRENGTH (HMS) SEBS

WINDOW ENCAPSULATION
HIGH FLOW SEBS; o-TPV

RADIATOR
HOSE/BOOTS
o-TPV

WIRE/CABLE
- COPE
- o-TPV

DOOR TRIM SKINS
- TPO RESURGING
- HI FLOW SEBS, o-TPV
- COPE

TRUNK LINER
- TPO (DEEP DRAW FORMABLE)

THE AUTO TPE MARKET
- GLOBAL FOOTPRINT REQ'D, RECENT LUXURY DRIVE
- KEY DRIVERS: LOW VOC/ODOR, OIL FUEL RESISTANCE, HEAT RESISTANCE, SUSTAINABILITY (BIO), WEIGHT SAVE/LUXURY LOOK/HAPTIC, SMART SURFACES

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
THE NEW NORMAL: SEBS

• Substantial resin overcapacity in China
  - Price/profitability erosion
  - Chinese/Taiwan producers targeting Western markets (especially with commodity grades)
  - TSRC and LCY leading the charge to Western markets. Sinopec starting?
  - Continued acquisitions search by major compounders
  - Late arrivals discouraged from entering China SEBS resin market: Dynasol, Kumho, and Versalis
  - Increased interest in specialty strategy by industry leaders to move from lower price commodity segments

• Commodity resin suppliers:
  - Targeting void left by Kraton and Kuraray in some cases with improved quality (e.g. TSRC Nantong plant)

• SEBS Attack on o-TPV applications:
  - Especially automotive. CTS is early leader, Toyota using SEBS body seals, window encapsulation is next target
  - TPVs becoming a commodity

• Feedstocks (especially butadiene) a key issue:
  - Especially as U.S. shifts to shale gas rather than naphtha

• Western compounders renew interest in investment in India (free trade country shipping vs investment in local plant capacity)

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
TPE DYNAMICS AND PARADIGM SHIFTS

REGIONAL SHIFTS
- TO ASIA, S. AMERICA
- RECENT SLOWED GROWTH
- U.S. RE-SHORING EFFECTS
- EMERGENCE OF ASIAN SUPPLIERS

ACQUISITIONS/JVs
- MITSUBISHI/CTS
- KRATON JV
- HEXPOL

SUBSTITUTION
- CASCADE EFFECT → LOWER COST TPEs
- BIO-TPEs

PROPERTY RANGE
- ANTI-BACTERIAL
- IMPROVED ADHESION
- WET GRIP
- CLEAN GRADES

PROCESS INNOVATIONS
- FOAMING (PARTICLE FOAM TPU);
  - CRITICAL FLUIDS
- SLUSH MOLDING
- TEXTILE COATING
- OVERMOLDING ON BEAD FOAMS
- DYNAMIC MOLD HEATING
- SELECTIVE LASER SINTERING

NEW MARKETS/APPLICATIONS
- AUTO: AIR DUCT/RESONATOR COMBINATION
- WIRE CABLE
- MEDICAL
- FOOTWEAR (TPU PARTICLE FOAMS)
- ELECTRONICS: HAPTICS/SOFT TOUCH

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
### TPE PARADIGM SHIFT

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<thead>
<tr>
<th></th>
<th>‘00–’12</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suppliers</td>
<td>Few</td>
<td>Increase in number and diversity</td>
</tr>
<tr>
<td>IP control</td>
<td>Easier</td>
<td>Difficult</td>
</tr>
<tr>
<td>Grades</td>
<td>Few</td>
<td>Grade proliferation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Commoditization of some grades</td>
</tr>
<tr>
<td>Market growth</td>
<td>High growth</td>
<td>- High growth (new sectors)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Market maturity (some sectors)</td>
</tr>
<tr>
<td>Paths to market</td>
<td>Single</td>
<td>Multiple</td>
</tr>
<tr>
<td>Competitive intensity</td>
<td>Limited</td>
<td>- Intensified</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Asian supplier push</td>
</tr>
<tr>
<td>Regional focus</td>
<td>West, China starting</td>
<td>Broadened to other BRICS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shift within Asia starting</td>
</tr>
<tr>
<td>BRICS/Asia growth</td>
<td>High &gt;2000</td>
<td>Slowed in 2013, Still high compared to West</td>
</tr>
<tr>
<td>Acquisition interest</td>
<td>Limited</td>
<td>Intensified</td>
</tr>
</tbody>
</table>

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
SUMMARY

• Region:
  - Global shift 4-5 years ago, key China role, recent re-shoring effects. BRICS party not over but slowed

• Concentration:
  - 10-12 large suppliers, many small compounders

• Entry barriers: easy to enter, IP not critical (formulation driven)

• Entry paths broadening: captive resin suppliers, distributors, compounders

• Target markets:
  - Auto (dominates o-TPV/TPO, global specs starting, SEBS penetration accelerating)
  - Footwear dominates TPU (recent market softening in China)
  - COPE broadening applications range (silky feel, high temperature)

• Growth dynamics:
  - EPDM, PVC substitution, automotive systems cost/weight save
  - Strong intra-TPE competition, cascade to lower cost TPEs
  - Broadening property envelope (all TPEs)
  - Bio-TPEs entering
  - Applications development shifted to tier 1s, end users
  - Growth: tied to unit volume growth (e.g. auto) and substitution

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
THANKS FOR YOUR ATTENTION

Robert Eller Associates LLC
CONSULTANTS TO THE PLASTICS AND RUBBER INDUSTRIES