THERMOPLASTIC ELASTOMERS:
MEETING AUTOMOTIVE CHALLENGES

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PREPARED FOR:
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TODAY’S OBJECTIVES

• The global automotive marketplace

• Current auto TPE example applications

• Identify the challenges

• How challenges met currently and potentially in the future with TPEs

• Future implications for TPE suppliers and the auto supply chain

• Examine the automotive TPE paradigm shift
THE AUTOMOTIVE TPE CHALLENGES

• Cost reduction

• Weight saving/help meet shifting emissions requirements

• Luxury experience without excessive cost adds

• Opening new applications

• Simplified parts fabrication

• Adhesion: the path to new TPE applications

• Controlling acoustics

• Controlling Foaming

• Globalization effects
  - implementing global TPE standards
  - implications of global platforms
  - regional supply chain shifts
### Importance of Automotive Varies Between TPEs

<table>
<thead>
<tr>
<th>TPE Type</th>
<th>Auto Share of Global Demand</th>
<th>Recent Incumbent</th>
<th>Note/ Auto Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPO</td>
<td>80%</td>
<td>None – TPO dominates</td>
<td>Bumper fascia, interior trim, skins</td>
</tr>
<tr>
<td>o-TPV</td>
<td>50%</td>
<td>NBR/PVC, ECO, CPE, EPDM</td>
<td>Boots/bellows, hose, short air ducts</td>
</tr>
<tr>
<td>SEBS</td>
<td>15%</td>
<td>EPDM, o-TPV</td>
<td>Auto share growing via soft touch, slush skins, seals</td>
</tr>
<tr>
<td>TPU</td>
<td>11%</td>
<td>EPDM, o-TPV</td>
<td>Grommets, sleeves, door sills, overmolded films, shift knobs, lamp seals, slush molding, wire/cable</td>
</tr>
<tr>
<td>COPE</td>
<td>10%</td>
<td>EPDM, o-TPV, fluorosilicones</td>
<td>Under-hood ducting, wire/cable, soft touch trim panels</td>
</tr>
</tbody>
</table>

**Source:** ROBERT ELLER ASSOCIATES LLC, 2013
• Dominant Incumbent:
  - EPDM

• TPE Challengers:
  - o-TPV, SEBS

• Dynamic vs. static requirements differ
  - Acoustic/wind noise performance (requirements increasing)
  - Adhesion (to glass, polycarbonate) emerging
  - Parts integration opportunities
  - Surface friction properties
  - Meeting regional performance differences
  - Overcoming institutional resistance
  - The small car challenge

• Large potential auto TPE market
- India pass car growth (2011-2020): 3 → 6-9 MM units
- India + China could represent growth potential (“11 – 20”) of 20MM vehicles or 50kT at current SEBS and o-TPV compound utilization rates with no further penetration

### N. AMERICAN SHIFT TO SMALLER SIZES ➔ AFFECTS TPE DEMAND

<table>
<thead>
<tr>
<th>SEGMENT</th>
<th>SALES SHARE,%</th>
<th>GAIN/LOSS,%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2005</td>
<td>2014</td>
</tr>
<tr>
<td>Compact utilities</td>
<td>6.0</td>
<td>13.4</td>
</tr>
<tr>
<td>Compact sedans</td>
<td>10.6</td>
<td>14.2</td>
</tr>
<tr>
<td>Mid-sized sedans</td>
<td>14.9</td>
<td>18.1</td>
</tr>
<tr>
<td>Wagons/Hatchback</td>
<td>5.3</td>
<td>7.5</td>
</tr>
<tr>
<td>Mid-sized utilities</td>
<td>15.2</td>
<td>12.4</td>
</tr>
<tr>
<td>Mid-sized PUTs</td>
<td>4.2</td>
<td>1.3</td>
</tr>
<tr>
<td>Full size PUTs</td>
<td>14.9</td>
<td>11.6</td>
</tr>
<tr>
<td>Vans/Minivans</td>
<td>8.7</td>
<td>5.3</td>
</tr>
<tr>
<td>Large sedans</td>
<td>8.2</td>
<td>4.1</td>
</tr>
<tr>
<td>TOTAL SALES, MM UNITS</td>
<td>16.9</td>
<td>15.8</td>
</tr>
</tbody>
</table>

DATA SOURCE: AUTO PACIFIC

Smaller vehicles share gain:
- smaller parts sizes
- increased pressure for soft interior features
- increased under-hood temperatures

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
AUTOMOTIVE: KEY TARGET MARKET FOR NEW 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

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

r/mydox/visio/auto key tgt for new tpe 2013.vsd
The challenges, how to:
- Implement global specifications (starting)
- Have a uniform global TPE supply and fabrication footprint
- Retain value associated with global standards
- Avoid commoditization and price challengers from local TPE suppliers

Background:
• Global platform usage is increasing
  - VWs MQB platform (5.5 MM global vehicles/yr) is leader
  - Platform volume for other OEMs (Toyota, Ford, Hyundai, GM is 2-3 MM vehicles/yr)
  - Typically on B/C segment vehicles
  - Creates opportunities for TPE suppliers with global footprint (a “must have”)

• TPEs offer greater product uniformity between regions for TPEs vs thermoset rubbers
  - OEMs prefer uniform products /grades from -the -bag rather than in-house compounded rubbers

TPE supplier solutions:
- Meet global specs (not always easy)/local pressures
- Assure lot-to-lot uniformity. Build an unassailable reputation
- Follow OEM regional shifts
- Assure global footprint
The challenges: save weight while adding value. Help meet steeply increased emissions requirements

Background:
- A key target with new fuel economy regulations
- TPEs generally have a density advantage vs. incumbents
- Weight savings via parts consolidation are possible (especially where fastening devices can be eliminated)

TPE solutions:
- Target metal substitution
- Look for hard/soft combinations
- Foaming
- Thin wall where possible
- Solve the adhesion problems
- Seek multi-functionality (e.g. EMI shielding TPE gaskets)
The challenge:
  - Reduce total parts cost

Background:
  - TPEs generally cost more than incumbent
  - OEMs working to examine total costs
  - OEM demanding high performance, form and function, perceived quality
  - Avoiding “cheap plastics” look

TPE solutions:
  - Parts consolidation
  - Redesign for ease of assembly
  - Labor cost reduction
  - Design for disassembly and recycling
The challenge:
- Improved adhesion is an application enabler
- Value add potential

Background:
- Application in coatings, multi-materials, construction, blends, fillers, reinforcements, surface decorations
- Logos

TPE solutions:
- Sprayed surface adhesion promoters
- Additives and compounds
- Usually polar/non-polar combinations
  -- MA/resin combinations
  -- SMA
The challenge:
- Incumbents can be replaced

Background:
- Many early entry TPEs over engineered
- Incumbents with brand recognition are vulnerable
- New suppliers in Asia challenge western TPE incumbents
- Warranty concerns
- BRIC quality/price tiers may differ than those of global incumbent TPE suppliers

TPE Solutions:
- Provide equal or greater properties vs. incumbent TPEs
THERMOPLASTIC ELASTOMERS IN WINDOW ENCAPSULATION

• Application: Rear quarter window encapsulation seal

• TPE Candidates: PUR, o-TPV, SEBS (H-SBC), 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
  - Example of 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

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
SHORT AIR DUCTS: MODERATE TEMPERATURE 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
TECHNICAL TRENDS: SEBS COMPOUNDS

• Improved SEBS grades
  - Slush moldable
  - Coated fabric grades
  - Able to compete with o-TPV in some applications

• 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-blow molding
  - Profiles

• Evolution of soft touch: silky feel

• Chinese commodity resin suppliers catching up in quality and versatility, not there yet
TECHNICAL TRENDS AFFECTING AUTOMOTIVE TPEs

• COPEs:
  - High temperature resistance
  - Adhesion
  - Haptics
  - Multi-shot

• TPOs:
  - High flow
  - Thin wall capabilities
  - Use in acoustic components
  - Role of POEs
  - Renewed skins growth

• o-TPVs:
  - High flow/glass adhesion grades for window encapsulation
  - Continued penetration into body seals and glass run channels
  - Improved attachment systems for body seals
GLOBAL AUTO TPE STRATEGY ANALYSIS WHEEL

REGIONAL AUTO PRODUCTION SHIFTS IMPLICATIONS
- ASIA, N. AMERICA, S. AMERICA
- EMERGING MARKET ADAPTATION
- INDUSTRY STRUCTURE DIFFERENCES
- QUALITY/PRICE TIER DIFFERENCES

GLOBALIZATION
- GLOBAL PLATFORM IMPLICATIONS
- REGIONAL SUPPLY CHAIN DIFFERENCES
- TIER 1 CONSOLIDATION

SUBSTITUTION
- CASCADE EFFECT → LOWER COST TPEs
- BIO-TPEs
- RUBBERS
- SUSTAINABILITY, BIO-TPEs ROLE

BROADER PROPERTY RANGE
- SOFT TOUCH
- IMPROVED ADHESION
- HIGHER TEMP CAPABILITY
- SURFACE QUALITY

NEW APPLICATIONS DRIVERS
- GROWTH VIA BOTH AUTO PROD’N AND SUBSTITUTION
- LUXURY (SOFT TOUCH APPROACHES)
- WEIGHT SAVE
- FABRICATION ASSEMBLY/MATERIALS COSTS SAVE
- RIDING ETP SUBSTITUTION’S COATTAILS
- FOLLOWING ELECTRONICS GROWTH

SOURCE: ROBERT ELLER ASSOCIATES LLC, 2013
THE PARADIGM HAS SHIFTED IN GLOBAL AUTOMOTIVE TPEs

- Grade commoditization → bifurcation into commodity & specialty

- Emerging auto markets:
  - Highest global growth rates

- Auto TPE demand via both unit volume growth and substitution

- Auto TPE supply chain broadening, new entrants

- Emergence of Asian TPE competition

- Emergence of global auto platforms

- Emergence of global TPE standards (starting with TPOs)

- Opportunities created by TPEs well suited to new challenges:
  - High temperature
  - Luxury feel
  - Lightweighting/parts integration
SUMMARY

• Most of the TPE challenges are easily met via the inherent capability of TPEs
• Globalization will help TPE penetration into automotive
• Auto TPE property envelope is expanding enabling access to new targets:
  - Heat resistance
  - Soft touch
  - Foaming
  - bio-TPEs

• Fabrication methods → offer process cost save
  - Two shot
  - Core-back methods
  - Co-processing (co-blow, coex)

• Global platform trend offers global TPE opportunities

• Regional auto TPE growth
  - Emerging markets (increased substitution to Western levels, organic growth)
  - Western, global TPE brands will benefit most in short term
  - Slowing of European markets
• “Windows” to TPE Growth:
  - Adhesion
  - Foaming
  - Parts consolidation
  - High temperature resistance
  - High flow
  - Soft touch
  - Surface quality
  - Interior lighting