Injection Overmolding Performance of Thermoplastic Polyester Elastomers (TPC-ET)

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What is TPC-ET?

TPE-E = Thermoplastic Polyester Elastomer
COPE = Copolyester Elastomer
TEEEE = Thermoplastic Ester-Ether Elastomer (EN ISO 1043-1)
TPC-ET = Thermoplastic Copolyester Polyether (EN ISO 18064)

Semi-crystalline Elastomer that Exhibits Good Chemical and Moisture Resistance, Easy Processing and Excellent Mechanical Properties

4GT-PTMO

Hard segment = crystalline PBT
Soft segment = amorphous polyether

Variation of properties by ratio and molecular weight of soft to hard segments

► Crystalline PBT segment gives Riteflex® TPC-ET high Tm, high strength, chemical resistance, wear and tear resistance, heat resistance, UV resistance.
► Amorphous polyether gives Riteflex® TPC-ET softness, elasticity, flexibility, resilience, hydrolysis resistance.
Rubbers and Thermoplastic Elastomers

► Durometer (hardness)
  - Measured on Shore A or D scale
  - Shore D 15-77 Riteflex® TPC-ET available

► Elongation
  - Elastic elongation typically >>100%
  - Retention of elongation (recovery) is a key measure of properties
**NBA - Thermoplastic Elastomers**

- **High-Price/Performance**
  - COPA
  - COPE
  - aTPU
  - TpSiV

- **Medium-Price/Performance**
  - TPU
  - SEBS Comp.
  - SEBS
  - TPV

- **Basic TPE**
  - SBS
  - TPO

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- **COPA** = PolyAmide-Ether based TPE
- **COPE** = PolyEster-Ether based TPE
- **aTPU** = Aliphatic Thermoplastic Urethane
- **TPU** = PolyUrethane based TPE
- **SEBS** = Styrene-Ethylene-Butylene Styrene Blockcopolymer / HSBC
- **TPV** = ThermoPlastic Vulcanisate (PP-EPDM)
- **TPO** = Thermoplast Olefinic TPE (PP-EPR)
- **SBS** = Styrene-Butadiene-Styrene Block Copolymer

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**THERMOPLASTIC ELASTOMERS**
Riteflex® COPE Key Properties

- High degree of **Flexibility & Resilience** (springs back into shape)
- High **Load bearing Capability**/excellent **Fatigue Resistance** in dynamic applications
- Excellent **low-temperature Ductility** (down to -60 °C)
- **Resistance to Chemicals**, especially automotive fluids (i.e. oil, grease, fat, gasoline)
- Good **Abrasion Resistance**
- **Consistent Properties** across a broad temperature range (-40°C to 100 … 120 °C)
- High continuous use temperature up to 150°C
- Excellent voltage Resistance (**CTI 600V**)
- **Sound & vibration damping** Capability
- High breathability for moisture, good **Water Vapor Transmission Rate (WVTR)** in thin layers or films, but excellent barrier properties.
- Excellent adhesion to ABS, PC, PC/ABS, Polyester and other polar substrates
- Plasticizer-free
- **Easy Processing** (injection molding, extrusion)
TPC-ET Compared to Other Elastomers

TPC-ET vs. TPUs
- Property retention across a broader temperature range
- Superior load-bearing capability and (flex) fatigue life
- Superior resistance to radiation & sterilization
- Better resistance to chemicals, UV and color stability
- Superior Low Temperature capabilities
- Better processability

TPC-ET vs. TPOs
- Higher peak temperature capability
- Wider temperature performance -40°C to 120°C
- Better low temperature capabilities >- 60°C

TPC-ET vs. Rubber
- Better long-term thermal stability and ozone resistance
- Recyclable
- Superior oxidation resistance
- Better flex fatigue compared to thermosets

BUT High Hardness ->Lower Hardness of TPC-ET Can be a Game Changer
New Riteflex® 200 Series

► Created to fulfill unmet need of softer polyester elastomers
  – Higher softness and elongation
  – Lower density

► Wide variety of specialized grades with different flexibility can be custom made
## Mechanical and Thermal Properties

<table>
<thead>
<tr>
<th>Preliminary Properties</th>
<th>Riteflex®-425</th>
<th>Riteflex-265B</th>
<th>RKX-280A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness – Shore A</td>
<td>77</td>
<td>65</td>
<td>80</td>
</tr>
<tr>
<td>Hardness – Shore D</td>
<td>25</td>
<td>18</td>
<td>35</td>
</tr>
<tr>
<td>Density</td>
<td>1.06</td>
<td>0.99</td>
<td>1.000</td>
</tr>
<tr>
<td>Flex Modulus</td>
<td>20 MPa</td>
<td>12 MPa</td>
<td>30 MPa</td>
</tr>
<tr>
<td>Tensile Modulus</td>
<td>16 MPa</td>
<td>11 MPa</td>
<td>30 MPa</td>
</tr>
<tr>
<td>Tensile Stress at 50% Strain</td>
<td>3 MPa</td>
<td>3.9 MPa</td>
<td>3.6 MPa</td>
</tr>
<tr>
<td>Tensile Strain at Break</td>
<td>750%</td>
<td>&gt;700%</td>
<td>&gt;700%</td>
</tr>
<tr>
<td>DTUL @ 0.45 MPa</td>
<td>42°C</td>
<td>37°C</td>
<td>52°C</td>
</tr>
<tr>
<td>Initial Tear Resistance</td>
<td>61 kN/m</td>
<td>49 kN/m</td>
<td>59 kN/m</td>
</tr>
<tr>
<td>Notched Charpy at 23°C</td>
<td>No Break</td>
<td>No Break</td>
<td>No Break</td>
</tr>
<tr>
<td>Vicat Softening Temperature</td>
<td>61°C</td>
<td>40°C</td>
<td>57°C</td>
</tr>
<tr>
<td>N. Charpy at -30°C</td>
<td>No Break</td>
<td>No Break</td>
<td>No Break</td>
</tr>
<tr>
<td>MFR – gm/min(°C/Kg)</td>
<td>13(190/2.16)</td>
<td>25 (190/2.16)</td>
<td>11.19 (190/2.16)</td>
</tr>
</tbody>
</table>
Injection overmolding Processing and Application
2-Component Molding: *new Ticona Tool*

**2-C Injection Molding Machine:**
- Full automated manufacturing of 2-component test specimen
- Support in different material combinations
- Visual evaluation of adhesion between 2 partners
- Usage: hard/soft applications

**2-C Mold with rotating Table:**
New 2-C Specimen:

Front side

Back side

Prepared for testing

Molding Simulation:

impingement point of soft component

Thickness
Hard: 4 mm
Soft: 2 mm
Peel Test According ISO 4578 / DIN EN 1464

test fixture / test machine / test speed: 100mm/min
2-Component Molding: Evaluation

- Overmolding @ window
- Maximal Kraft
- Analysis area
- Gate mark
- Impingement
- Soft component
- Hard component
- Overlap of the soft component
- Impingement point
2-Component Molding Trials: Polar amorphous substrate- PC and ABS

Excellent adhesion of both Riteflex® 265B and 280A
# Riteflex® Excellent Adhesion on many substrates

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Peel force (N/mm)</th>
<th>rating</th>
<th>remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>&gt;20</td>
<td>Excellent</td>
<td>Natural fit giving maximum adhesion and cohesive fracture in peel for full RF portfolio range</td>
</tr>
<tr>
<td>PC/ABS</td>
<td>&gt;15</td>
<td>Excellent</td>
<td>Natural fit giving maximum adhesion and cohesive fracture in peel for full RF portfolio range</td>
</tr>
<tr>
<td>ABS</td>
<td>&gt;10</td>
<td>Excellent</td>
<td>Good and consistent adhesion strength for full portfolio range</td>
</tr>
<tr>
<td>Riteflex (&gt;55D)</td>
<td>&gt;10</td>
<td>Excellent</td>
<td>Challenging for soft RF grades due to high meltpoint of RF</td>
</tr>
<tr>
<td>PBT</td>
<td>&gt;10</td>
<td>Good</td>
<td>Challenging for soft RF grades due to high meltpoint of PBT</td>
</tr>
<tr>
<td>PET</td>
<td>&gt;5</td>
<td>Good</td>
<td>Challenging for soft RF grades due to high meltpoint of PET</td>
</tr>
<tr>
<td>POM</td>
<td>&gt;5</td>
<td>Good</td>
<td>Specific Hostaform grades only</td>
</tr>
<tr>
<td>PPS</td>
<td>&gt;3</td>
<td>Fair</td>
<td>Challenging for soft RF grades due to high meltpoint of PPS</td>
</tr>
<tr>
<td>PVC</td>
<td>&gt;3</td>
<td>Fair</td>
<td>Full RF portfolio range.</td>
</tr>
<tr>
<td>PA</td>
<td>&lt;2</td>
<td>poor</td>
<td>No or limited compatibility.</td>
</tr>
<tr>
<td>PP</td>
<td>&lt;2</td>
<td>poor</td>
<td>No compatibility.</td>
</tr>
<tr>
<td>PE</td>
<td>&lt;2</td>
<td>poor</td>
<td>No compatibility.</td>
</tr>
</tbody>
</table>
### Riteflex® Adhesion Benchmark

<table>
<thead>
<tr>
<th>Overmolded Resin</th>
<th>Peelforce vs Riteflex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riteflex 425</td>
<td>100%</td>
</tr>
<tr>
<td>Adhesion modified SEBS (Urethane based)</td>
<td>54%</td>
</tr>
<tr>
<td>Adhesion modified SEBS (Polyester based)</td>
<td>41%</td>
</tr>
<tr>
<td>Silicon Rubber TPV (Urethane based)</td>
<td>49%</td>
</tr>
</tbody>
</table>

- Molded in real 2 shot tool customer part.
- Substrate 20 GR PC
- All soft TPE have hardness in 70-75 shore A range
Adhesion of Riteflex to Polycarbonate (PC) is considered as the “ultimate” adhesion = cohesion:
- up to 700N (≈ bears 70kg load) @ 30mm width/2mm thickness → ca. 12MPa.
Adhesion of Riteflex to ABS is lower compared to PC, but still very good
Melt temperature has an important effect.
Broad range of (polar) substrates possible
Additives may influence adhesion levels in real applications
Adhesion levels typically strongly depend on molding conditions and interfacial temperature conditions to allow chain mobility to interact with the substrate

GOOD ADHESION IS GOOD CHEMICAL COMPATIBILITY + CO-PROCESSING COMPATIBILITY
Better Colorability of Riteflex 200 vs RF400

- Richer, deeper colors
- Brighter whites
- More chromatic colors
- More brilliant anodized colors
- Darker Black
Summary: New Riteflex 200 series

- Softer COPE (60A to 80A) without sacrificing on COPE properties!
- Low friction/softer touch (dry feel) compared to standard COPE
- Enhanced colorability, Enhanced UV, and color stability.
- Good Chemical resistance and stain resistance properties
- Excellent adhesion on many polar substrates in 2k overmolding
- Resilience and good fatigue life
- Wide variety of application specific grades with different flexibility and additives can be custom made, Laser-markable, heat stabilized and fire retardant options under development
- Targeting applications in Consumer and Consumer Electronics market space
  - Overmolding, soft touch, seals, trims dampers etc.
  - Wire and Cable jacketing and strain reliefs
  - Soft cases and covers
  - Wearable electronics - bands
Thank you for your attention!
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