Fort Wayne Rubber & Plastics Group—Unique Compounding Ingredients: An Overview
By Chris Ryan, ChemSpec Technical Sales Manager
<table>
<thead>
<tr>
<th>Product Line</th>
<th>Market(s) Served</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerators</td>
<td>Rubber, Plastic</td>
</tr>
<tr>
<td>Activators – Zinc Oxide</td>
<td>Rubber</td>
</tr>
<tr>
<td>Antioxidants</td>
<td>Rubber, Plastics, Adhesives, Fuels, Lubricants</td>
</tr>
<tr>
<td>Blowing Agents &amp; Activators</td>
<td>Rubber, Plastic</td>
</tr>
<tr>
<td>Calcium Products Oxide / Hydroxide</td>
<td>Rubber, Plastic, Metal, Wastewater, Mining</td>
</tr>
<tr>
<td>Dithiocarbamates</td>
<td>Rubber, Wastewater, Mining</td>
</tr>
<tr>
<td>Fillers (i.e. Tremin Wollastonite)</td>
<td>Rubber, Plastic, (WPC), Coating, Adhesive</td>
</tr>
<tr>
<td>Functional Fillers (i.e. Hoffmann Mineral)</td>
<td>Rubber, Coatings, Plastic</td>
</tr>
<tr>
<td>Functional Polymers</td>
<td>Wood Plastic Composite, Plastic, Rubber</td>
</tr>
<tr>
<td>Sulfur / Insoluble Sulfur</td>
<td>Rubber, Plastic, Latex, Wire/Cable</td>
</tr>
<tr>
<td>Magnesium Oxide / Hydroxide</td>
<td>Rubber, Plastic, Adhesives, Coatings</td>
</tr>
<tr>
<td>Mold Releases / External Lubricants</td>
<td>Rubber, Plastics, Composites</td>
</tr>
<tr>
<td>Molecular Sieve</td>
<td>Rubber, Adhesives, Coatings</td>
</tr>
<tr>
<td>Plasticizers</td>
<td>Rubber, Plastic, Adhesive, Coating</td>
</tr>
<tr>
<td>Polyethylene – Wax</td>
<td>Rubber, Plastic</td>
</tr>
<tr>
<td>Process Aids / Lubricants</td>
<td>Rubber, Plastic, Wood-Plastic Composite</td>
</tr>
<tr>
<td>Green, High Performance Process Oils</td>
<td>Rubber</td>
</tr>
<tr>
<td>Release Agents</td>
<td>Rubber, Tire, Plastic</td>
</tr>
<tr>
<td>Silane Coupling Agents</td>
<td>Rubber, Adhesives, Filler Treatments, Sealants, Mining, Coatings</td>
</tr>
<tr>
<td>Solvent Dyes</td>
<td>Ink, Ball Pen &amp; Continuous Ink Jet</td>
</tr>
<tr>
<td>Synthetic Rubber</td>
<td>Rubber, Adhesives, Sealants</td>
</tr>
<tr>
<td>Titanium Dioxide</td>
<td>Rubber, Coatings</td>
</tr>
<tr>
<td>Vamac / Polyacrylate Additives</td>
<td>Rubber</td>
</tr>
<tr>
<td>Wax – Paraffin / Microcrystalline</td>
<td>Rubber, Hot Melt Adhesives</td>
</tr>
<tr>
<td>Zinc Oxide</td>
<td>Rubber, Adhesives, Coatings</td>
</tr>
</tbody>
</table>
HOFFMANN MINERAL COMPANY HISTORY

- Founded in 1895
- Start of production in 1903
- Mining, processing, and marketing of Neuburg Siliceous Earth (NSE)
- Family-owned, 4th Generation
- Last remaining company mining NSE
- Known deposits will last 100+ years (2-3% growth accounted for)
- Capacity: 60,000 metric tons per year
Emergence of a Unique Mineral
Neuburg Siliceous Earth Structure

- Natural combination of crypto-crystalline silica, amorphous silica and lamellar kaolinite.
- Impossible to be separated by physical means.
- The particles of the silica fraction have a smooth surface and consist of aggregated primary particles (ca. 200 nm).
- The fusion with lamellar kaolinite created a unique mineral structure.

\[
\text{Crypto-crystalline and amorphous silica} + \text{Kaolinite (lamellar)} = \text{Neuburg Siliceous Earth}
\]
Neuburg Siliceous Earth Structure

CCS, as hexagonal di-pyramids

1  2  3

AS
Sillitin / Sillikolloid: Standard product line; natural mineral, classified, untreated.

Puriss grades: Processed to reduce agglomerate content.

Aktisil: Surface-treated grades of Sillitin.

Silfit: Calcined Sillitin (Z 86).

Aktifit: Surface-treated Silfit.
NSE
Particle Size Distribution

SILLITIN V
SILLITIN N
SILLITIN Z
SILLIKOLLOND P
NSE
Product Range

Increase incoor mutuality

Decrease in average particle size

SILLITIN V
SILLITIN N
SILLITIN Z
SILLIKOLLOID P

ChemSpecAdditives.com
<table>
<thead>
<tr>
<th></th>
<th>Bulk density [g/cm³]</th>
<th>Tamped density [g/cm³]</th>
<th>BET $^2$ [m/g]</th>
<th>Oil absorption [g/100g]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SILLITINV85</td>
<td>0.35</td>
<td>0.60</td>
<td>8</td>
<td>45</td>
</tr>
<tr>
<td>SILLITINV88</td>
<td>0.30</td>
<td>0.60</td>
<td>8</td>
<td>45</td>
</tr>
<tr>
<td>SILLITINN82</td>
<td>0.30</td>
<td>0.50</td>
<td>11</td>
<td>45</td>
</tr>
<tr>
<td>SILLITINN85</td>
<td>0.30</td>
<td>0.50</td>
<td>10</td>
<td>45</td>
</tr>
<tr>
<td>SILLITINN87</td>
<td>0.30</td>
<td>0.50</td>
<td>10</td>
<td>45</td>
</tr>
<tr>
<td>SILLITINZ86</td>
<td>0.25</td>
<td>0.40</td>
<td>12</td>
<td>55</td>
</tr>
<tr>
<td>SILLITINZ89</td>
<td>0.21</td>
<td>0.40</td>
<td>11</td>
<td>55</td>
</tr>
<tr>
<td>SILLIKOLLOIDP87</td>
<td>0.25</td>
<td>0.35</td>
<td>13</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>DINISO 903-1976</td>
<td>DINISO 787part11</td>
<td>DINISO 9277</td>
<td>DINISO 787part5</td>
</tr>
<tr>
<td>Product</td>
<td>Basedon</td>
<td>Surfacemodification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>--------------</td>
<td>-------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AKTISILVM56</td>
<td>SILLITINZ86</td>
<td>Vinylsilane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AKTISILVM56/89</td>
<td>SILLITINZ89</td>
<td>Vinylsilane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AKTISILMAM</td>
<td>SILLITINV88</td>
<td>Methacrylicsilane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AKTISILMAM-R</td>
<td>SILLITINV85</td>
<td>Methacrylicsilane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AKTISILQ</td>
<td>(b) SILLITINV90</td>
<td>Methacrylicsilane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AKTISILEM</td>
<td>SILLITINZ86</td>
<td>Epoxysilane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AKTISILAM</td>
<td>SILLITINZ86</td>
<td>Aminosilane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AKTISILMM</td>
<td>SILLITINZ86</td>
<td>Mercaptosilane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AKTISILWW</td>
<td>SILLITINV88</td>
<td>Paraffin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AKTISILPF216</td>
<td>SILLITINZ86</td>
<td>Tetrasulfidesilane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) AKTISILPF777</td>
<td>SILLITINZ86</td>
<td>Alkylsilane</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Strongly hydrophobic, non-reactive</td>
<td>(b) Captiveuse</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Check-out the Hoffmann Website!

https://www.hoffmann-mineral.com
Homepage
Technical Reports

https://www.hoffmann-mineral.com
Process Aids: Applications of “Ultra”

performance additives

Malaysia • United States • Italy
Ultralube 200 & Ultralube 330

**Function**

- Main function is dispersion of highly active white & black fillers.
- Improves Compound processing & reduces viscosity.
- Prevents sticking to processing equipment.
- Reduces mixing time, energy and temperature.
- Improves mold release of cured product.
- Very cost effective internal lubricant

**Special Applications**

- 2-4phr as a dispersing agent for carbon black masterbatches
## Ultralube 200 & 330 (cont’)

| **Footwear** | Outsole – (2phr) improves fillers / curatives dispersion  
|             | Foxing strips – (2phr) improves extrusion / calendaring  
| **Rubber rolls** | 2phr – improves fillers / curatives dispersion  
|             | - excellent surface finish  
| **Automotive parts** | Seals & gaskets – (2phr) improves mold release  
|             | Fuel hoses – (2phr) enhances extrusion  
| **Cable covers** | CR/SBR blend – (1.5phr) improves physical properties  
|             | - gives longer scorch time  
|             | - no influence on electrical resistivity  
| **Belting** | 2phr – improves filler dispersion  
|             | - excellent flow property & good release  
| **Tire** | Truck tread – (2phr) improves hot tear, best use together with 2phr compatibilizer (UB4000, 6000, 5500)  
|             | Radial T/B tread – 2~3phr with ISAF-HS or SAF blacks  
|             | Side wall – 2phr + 2phr UB4000 (For white sidewall – use UB6000)  

---

ChemSpecAdditives.com
Ultralube 220 and WF 103

**Function**

- Excellent flow properties and good mold release for special polymers, especially NBR.
- Improves filler dispersion.
- Suitable for continuous vulcanization, e.g. UHF, salt bath and fluidized bed.
- Highly effective for ALL polymers.

**Applications**

Can be used in ALL application fields.

**Special Applications**

1.5 phr UL220 eliminates “extrusion mark” in NBR roll covers.
2 phr of WF 103 helps mold release and minimizes mold fouling
Ultralube 160

**Function**

- Improves flow properties of rubber compounds.
- Eliminates sticking to mill rolls, internal mixer rotors & calendar bowls.
- Reduces internal friction, energy consumption & mixing temperature.
- Improves mold release and gives better surface finish.
- Has a stabilizing effect in CR compounds.
- Recommended for ALL polymers as well as thermoplastic elastomers.

| **-EPDM,SBR,CR etc** | - improves mold flow and gives better surface finish.  
- eliminates sticking to calender bowl.  
- faster injection time and reduce rejects.  
- improves mold release. |
| **- TPE** | |
| **- EVA** | |
| **Automotive parts**  
- *weather strips*  
- *injection moldings* | - improves extrusion characteristic (EPDM)  
- ensures complete mold fill, reduce reject rate & gives longer machine life. |
## Ultralube 160 (cont’)

|            | 1.5phr in PVC/NBR cover compound  
|            | - eliminates mill sticking, smoothes out extrudate & reduces die swell.  
|            | 2phr in CPE – eliminates sticking & faster extrusion.  
| **Cable**  |  
| **Belting**| 2phr in CR fan belt  
|            | - eliminates sticking to mill rolls, internal mixer rotors and calendar bowls.  
|            | - longer scorch time & improved surface finish.  
| **Profiles**| 2phr in EPDM extrusion compounds  
|            | - improves filler dispersion, better flow, improved extrusion rates and better surface appearance.  
| **Tire**   | - used in high performance and racing tread to reduce mill sticking.  
|            | - 2phr (max) in bladder compound to prevent sticking to internal mixer rotors.  

# Ultralube 420

**Function**

- Improves filler incorporation and dispersion, particularly for high filled compounds (EPDM)
- Enhances flow ability and release properties.
- Low peroxide demand.
- Suitable for NR, SBR, NBR, CR and especially for EPDM.

| Extrusion Profiles | EPDM weather strips – Faster extrusion  
|                   | - Improves carbon black dispersion.  
|                   | Hoses – Faster extrusion and lower die swell.  
| Footwear          | Outsole – Improves filler dispersion  
|                   | - Enhances flow properties.  
| Molded Goods      | Better dimensional stability  
|                   | - improves mold flow  
|                   | - improves mold release.  

ChemSpecAdditives.com
Ultralube IMX

**Function**
- Specially designed to ease processing of ECO rubber.
- Improves mold flow and release properties.
- Reduces sticking during mixing and from processing equipment.
- Reduces mold fouling.
- Works also well in HNBR, XNBR

**Applications**
Automotive parts – fuel hose, seal and gasket.
Belting.
Antistatic.
Ultralube 790

**Function**

- Specially designed to ease processing of FKM, HNBR and ACM rubbers.
- Improves mold flow and release properties.
- Reduces sticking of compound to mixing and processing equipment.
- Reduces mold fouling.
- Shows no adverse effect on compression set or fuel resistance.
- Low volatility in hot – air ageing; no shrinkage after post cure.

**For FKM/HNBR/ACM Applications**

Automotive parts – fuel hose, seal and gasket.

Belting.
Ultraflow 500 & Ultraflow 600

**Function**

- Physical peptizer
- Reduces viscosity by lubrication.
- Improves plasticity and flow properties.
- Reduces mixing cycles (time / energy).
- Enhances rapid incorporation of fillers.
- Recommended for all polymers, except halogen containing elastomers.

**UF600 – having lower melting point and can be mixed on open mill**
### Ultraflow 500 & 600 (cont’)

| High dynamic parts | – improves flow.  
|                    |   - improves dispersion of silica  
|                    |   - faster mixing  
| Rubber Rolls       | Improves flow.  
|                    | Increase extrusion rate / Lower die swell.  
|                    | Lower shrinkage.  
| Tire               | - UF500 (2-3phr)  
|                    | - UF500 (2-3phr)  
|                    | - UF500 (2-3phr)  
|                    | - UF550 (2-3phr)  
|                    | - UF600 (2phr)  
|                    | - UF500 (2.5phr)  
|                    | - UF600 (2phr) + UB4000 (2phr) very common.  

---

[ChemSpecAdditives.com](http://ChemSpecAdditives.com)
Ultraflow 440

**Function**

- New generation type of physical peptizer for NR and synthetics.
- Excellent lubrication and viscosity reducer, especially suited for extrusions.
- Reduces extrusion die swell. Stabilizes viscosity.
- Shorter mixing cycles by faster filler incorporation.

**Applications**

- Similar to Ultraflow 500 & 600 but much more effective. (can use 30 – 50% lower)
- Very suitable to be used in Extrusion and Injection rubber articles.

**Special Applications**

- 4 phr – eliminates “spiral flow mark” on roll cover
- 2.5 phr – improves “Green Tire” processing
- 2 phr – improves surface finish, and mold release
Ultraflow 700 S

**Function**

- Effective Additive for highly loaded compounding
- Excellent viscosity reducer, improves extrusion/mold flow
- Reduces extrusion die swell.
- Shorter mixing cycles by faster filler incorporation.
- Prevents re-agglomeration of silica (Payne effect)

**Applications**

- Helps incorporate silica and high filler loadings
- Very suitable to be used in Extrusion and Injection rubber articles.

**Special Applications**

2.5 – 3 phr – improves processing and filler dispersion
Ultraflow 800

**Function**

- New zinc free additive for most common polymer systems
- Excellent lubrication and viscosity reducer, improves extrusion- and mold flow
- Reduces extrusion die swell.
- Shorter mixing cycles by faster filler incorporation.

**Applications**

- Very suitable to be used in Extrusion and Injection rubber articles.
Ultraflow 840

Function

- Improves reversion resistance and maintain physical properties on over cure.
- Improves dynamic properties – Lower heat buildup.
- Reduces (improves) compression set at elevated temperatures.
- Strong activating effect with significant enhancement of modulus.
- Lower rolling resistance in tire applications.
- Improves injection behavior for molded goods.

<table>
<thead>
<tr>
<th>Rolls, belting</th>
<th>-- improves processing and physicals. Particularly for tough / high hardness compound.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NR Dynamic parts</td>
<td>2.5phr gives excellent reversion resistance in both NR and SBR or NR blend based compounds</td>
</tr>
</tbody>
</table>
## Ultraflow 840 (cont')

<table>
<thead>
<tr>
<th>Tire</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Treads</em></td>
<td>- 2.5phr improves heat resistance.</td>
</tr>
<tr>
<td><em>Truck treads</em></td>
<td>- Lower heat buildup.</td>
</tr>
<tr>
<td>- Retreads</td>
<td>- 2.5phr UF840 + 2phr stearic acid</td>
</tr>
<tr>
<td>- Bias truck /OTR carcass</td>
<td>- faster extrusion, lower running temperature and lower rolling resistance.</td>
</tr>
<tr>
<td>- Shoulder compound</td>
<td>- 2.5phr to improve extrudability.</td>
</tr>
<tr>
<td>- Bead apex</td>
<td>- 3phr improves processing &amp; physicals.</td>
</tr>
<tr>
<td>- Solid tire</td>
<td>- 2.5phr prevents delamination.</td>
</tr>
<tr>
<td></td>
<td>- 3phr to improve processing.</td>
</tr>
<tr>
<td></td>
<td>- 2.5phr improves reversion resistance and lower heat buildup.</td>
</tr>
</tbody>
</table>

* -- major areas of use for lower HBU to reduce tread and carcass separation.
Ultrapep 148 & Ultrapep 96

**Function**

- Viscosity reduction of NR by chemical peptization with added chain lubrication.
- Suitable for pre-mastication as well as single stage process.
- Effective on open mill above 80 degree C and in internal mixer up to 160 degree C.
- Rapid and even dispersion with no “Hot Spot”.
- Activity: UP148 > UP96 (which gives better dispersion and processing due to higher dispersing agent content).

**Applications**

Mooney reduction (0.1 ~ 0.3 phr).
3-5 phr for breaking down tough NR.
Ultrapep 90

Function

- Viscosity reduction of NR with controlled low chain cutting.
- Suitable for pre-mastication as well as single stage process!
- Effective on open mill above 80 degree C and in internal mixer up to 160 degree C.
- Rapid and even dispersion with no “Hot Spot”.
- Gives better ageing and dynamic properties than standard peptizer.
- No additional lubricant additives needed!

Applications

Mooney reduction (1 - 2phr).

ChemSpecAdditives.com
Ultrablend 4000, 5000, 5500 & Ultrablend 6000

Function

- Improves homogeneity of polymer blends.
- Improves batch-to-batch uniformity.
- Enhance green tack.
- Improves compound flow.
- Shorter mixing cycles
- Improves processing – calendering & extrusion.

(Also applied to single polymer based compounds)

** UB 4000 for black compound, UB 5000, 5500 & UB 6000 for light colored articles.
Ultrablend (cont’)

<table>
<thead>
<tr>
<th>Polymer Blends</th>
<th>3 ~ 5phr needed for good homogeneity.</th>
</tr>
</thead>
</table>
| Ball bladder (IIR based) | 3 ~ 4phr – improves processing  
- improves cured adhesion  
- further improves air impermeability. |
| Belting | 4phr is common for better processing and cured adhesion. Also reduces batch-to-batch variation. |
| Tire | 5phr for synthetics and mainly retreads.  
3phr UB4000 + 2phr UL200 to improve hot tear resistance. |
| - Tread | 5phr for improved extrusion.  
2phr UB4000 + 2phr UL200 (for white sidewalls use UB6000 or 5500 instead) |
| - Bead apex | 7phr UB4000 replacing oil. |
| - Side walls | 4phr. |
| - Inner liners | 5phr replacing castor oil (passenger).  
2.5phr replacing half castor oil (truck). |
| - OTR treads | 4phr to improve processing / enhances tack & adhesion. |
| - Bladder | 2.5phr replacing half castor oil (truck). |
| - Valve compound | 4phr to improve processing / enhances tack & adhesion. |
SAFIPOL TPU7840
Polybutadiene-based Thermoplastic Polyurethanes in Rubber compounding
Product Distribution Channel

EXCLUSIVE N. AMERICA DISTRIBUTOR

PRODUCED IN EUROPE

ChemSpecAdditives.com
Potential areas of application

- Improved Chemical Resistance and Hydrolytic Stability
  
  \textit{...adhesive and sealant formulations}

- Demonstrated Adhesion to both rubber compound and PU
  
  \textit{...an intermediate tie-layer in multi-component articles including hose, belt and tires}

- Increased Modulus, Traction while maintaining Hysteresis
  
  \textit{...additives for tire compounds and other rubber components}

- Improved Flex Fatigue properties at higher loadings

- \textit{additive for applications requiring improved durability}

- Increased Electrical Resistivities
  
  \textit{...wire and cable jacket applications, electrical insulation}
HSC liquid polymer technology

- **Trade name**: Ricon, PolyBd, Krasol

- **Molecular weight**: (1000 – 10,000)g/mol
- **Vinyl/styrene content**
- **Tg between**: –95°C and 0°C
- **Hydrogenation** (partial/complete)

**Possible functionalization**
- Hydroxyl
- Epoxy
- Maleic anhydride
- Acrylate

ChemSpecAdditives.com
Thermoplastic Urethane -- SAFIPOL TPU7840

TPU7840 is matured PU under granulate form

Linear structure, which provides thermoplastic properties:

- Mold material
- Possibility to blend with other elastomer (polar and non-polar)
TPU properties

- High hydrophobicity
- High acid and base resistance compared to most polyether TPUs
- Co-reticulation with diene elastomers possible (Sulfur and peroxides)
- Can be used as compatibilizer between non-compatible materials
- Higher electrical resistivity compared to polyether TPUs

Typical characteristics:

<table>
<thead>
<tr>
<th>Typical values of PolyBdTPU</th>
<th>Stress at 100% (MPa)</th>
<th>Stress at 300% (MPa)</th>
<th>Tensile strength (MPa)</th>
<th>Elongation at break (%)</th>
<th>Moulding temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safipol TPU7840</strong></td>
<td>6.5</td>
<td>11.6</td>
<td>17.3</td>
<td>490</td>
<td>155-160°C</td>
</tr>
</tbody>
</table>
Safipol TPU7840 – Adhesive Tie-Layer

- **TPU7840** Structure creates opportunities to compatibilize dissimilar elastomeric materials
  - Diene segment ⇒ interacts with diene-based compound
  - Urethane segment ⇒ interacts with PU material
- System studied:
  - **in-situ curing of laminate to** $t_{90}$ of rubber formulation

**Polyurethane Component**

**Rubber Compound**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>phr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Productive</td>
<td></td>
</tr>
<tr>
<td>SBR</td>
<td>100.0</td>
</tr>
<tr>
<td>Carbon Black (N330)</td>
<td>50.0</td>
</tr>
<tr>
<td>Process Oil (paraffinic)</td>
<td>10.0</td>
</tr>
<tr>
<td>Antioxidant (TMQ)</td>
<td>1.0</td>
</tr>
<tr>
<td>Zinc Oxide</td>
<td>5.0</td>
</tr>
<tr>
<td>Stearic Acid</td>
<td>2.0</td>
</tr>
<tr>
<td>Productive</td>
<td></td>
</tr>
<tr>
<td>Sulfur</td>
<td>2.5</td>
</tr>
<tr>
<td>Accelerator (TBBS)</td>
<td>0.7</td>
</tr>
</tbody>
</table>
**SAFIPOL TPU7840 – Adhesive Tie-Layer**

Adhesion of Thermoplastic Materials to Rubber Compound

<table>
<thead>
<tr>
<th>Component A</th>
<th>Component B</th>
<th>Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubber compound</td>
<td>Safipol TPU7840</td>
<td>cohesive</td>
</tr>
<tr>
<td>Rubber compound</td>
<td>Polyether TPU</td>
<td>adhesive</td>
</tr>
<tr>
<td>Rubber compound</td>
<td>Polyester TPU</td>
<td>adhesive</td>
</tr>
<tr>
<td>Rubber compound</td>
<td>SBS</td>
<td>cohesive</td>
</tr>
<tr>
<td>Rubber compound</td>
<td>SIS</td>
<td>cohesive</td>
</tr>
</tbody>
</table>

**Only diene-containing thermoplastic materials adhered to cured rubber compound**
The diene-urethane segmental structure of TPU7840 can successfully mate rubber components to urethane components.

Only TPU 7840 consistently adhered to PU components.

<table>
<thead>
<tr>
<th>Component A</th>
<th>Component B</th>
<th>Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safipol TPU7840</td>
<td>Polyether TPU</td>
<td>cohesive</td>
</tr>
<tr>
<td>Safipol TPU7840</td>
<td>Polyester TPU</td>
<td>cohesive</td>
</tr>
<tr>
<td>SBS TPE</td>
<td>Polyether TPU</td>
<td>adhesive</td>
</tr>
<tr>
<td>SBS TPE</td>
<td>Polyester TPU</td>
<td>adhesive</td>
</tr>
</tbody>
</table>
Millathane Millable Polyurethanes are known for their excellent strength and abrasion resistance properties. In many instances, it is desirable for a formulator to use an outer layer of Millathane compound over a general purpose rubber (e.g. SBR / NR) compound to aid with abrasion resistance. The bonding of Millathane millable polyurethane compounds to other types of rubber during curing is, however, often difficult, due to differences in polymer compositions and curing systems.

**SAFIPOL TPU7840**, a special thermoplastic polyurethane distributed by ChemSpec (a Safic-Alcan product), when added to sulfur-cured Millathane E34 or Millathane E40 compounds, greatly improves bonding during curing to NR and SBR compounds. The adhesion is further improved when the TPU7840 is added to the substrate compound.
RESULTS

Bond strength (T-Peel) test results on test compounds bonded together during curing:

<table>
<thead>
<tr>
<th>Millathane Compound*</th>
<th>Substrate Compound*</th>
<th>Adhesion, lbf/in (N/mm)</th>
<th>Failure Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millathane E34</td>
<td>Natural Rubber</td>
<td>7 (1.3)</td>
<td>Adhesive</td>
</tr>
<tr>
<td>Millathane E34 + 15 TPU7840</td>
<td>Natural Rubber</td>
<td>&gt; 36 (&gt;6.3)</td>
<td>Cohesive**</td>
</tr>
<tr>
<td>Millathane E40</td>
<td>SBR</td>
<td>8 (1.4)</td>
<td>Adhesive</td>
</tr>
<tr>
<td>Millathane E40 + 5 TPU7840</td>
<td>SBR</td>
<td>17 (3.0)</td>
<td>Adhesive</td>
</tr>
<tr>
<td>Millathane E40 + 15 TPU7840</td>
<td>SBR</td>
<td>18 (3.2)</td>
<td>Adhesive</td>
</tr>
<tr>
<td>Millathane E40 + 25 TPU7840</td>
<td>SBR</td>
<td>23 (4.0)</td>
<td>Adhesive</td>
</tr>
<tr>
<td>Millathane E40</td>
<td>SBR + 10 TPU7840</td>
<td>14 (2.5)</td>
<td>Adhesive</td>
</tr>
<tr>
<td>Millathane E40 + 5 TPU7840</td>
<td>SBR + 10 TPU7840</td>
<td>&gt; 36 (&gt;6.3)</td>
<td>Cohesive**</td>
</tr>
<tr>
<td>Millathane E40 + 15 TPU7840</td>
<td>SBR + 10 TPU7840</td>
<td>&gt; 36 (&gt;6.3)</td>
<td>Cohesive**</td>
</tr>
<tr>
<td>Millathane E40 + 25 TPU7840</td>
<td>SBR + 10 TPU7840</td>
<td>&gt; 36 (&gt;6.3)</td>
<td>Cohesive**</td>
</tr>
</tbody>
</table>

*sulfur-cured Millathane compounds (MBTS/MBT/Thanecure® ZM/Sulfur cure system), sulfur-cured NR and SBR compounds (CBS/Sulfur cure system). Formulations are available upon request.

**within substrate compound

APPLICATIONS

Improved bonding of Millathane millable polyurethane compounds to general purpose rubber compounds would be useful for conveyor belting, footwear, rubber covered rollers, and other applications where a strong, abrasion-resistant layer of Millathane millable polyurethane compound would be beneficial.

***The recommendations for the use of our products are based on tests believed to be reliable. However, we do not guarantee the results to be obtained by others under different conditions. Nothing in this literature is intended as a recommendation to use our products so as to infringe on any patent. Millathane® and Thanecure® are registered trademarks of TSE Industries, Inc.***
Summary

• Diene-based TPUs have a unique structure incorporating both soft, hydrophobic diene and hard polar urethane segments

• For rubber applications, when used as a tie layer, it allows adhesion improvement

• When used as an additive in a rubber formulation, it leads to:
  - higher modulus
  - higher tensile strength
  - higher tear properties
  - larger rebound difference
  - improved crack resistance
THANK YOU

ChemSpec, Ltd.
1559 Corporate Woods Parkway
Uniontown, OH 44685
(Toll Free) 800-200-4753

Chris Ryan
Technical Sales Account Manager
(Cell) 330-541-1277
(E-mail) Cryan@ChemSpecLtd.com