Trimethylsiloxyxysilicate Film Formers
Specsil series
Dr. Tony Gough
Film Formers

“Film Formation” is important to a wide range of Personal Care Products

► Hair Care
  • Styling Aids (Hair fixatives)
  • Hair treatments: Shine, Frizz control, Conditioning, “Anti-aging ingredients”

► Skin Care
  • Moisturization: Occlusive films to retard Trans Epidermal Water Loss
  • Skin Protectants
  • Active Delivery: Uniform films may aid in the efficacy of oil soluble actives

► Sun Care
  • Water Resistance of sunscreen actives
  • Uniformity of sun protection through good spreading properties of the silicone

► Color Cosmetics
  • Water resistance, Wash-off resistance, transfer resistance / durability
  • Uniform pigment
  • Slow or prevent pigment creep
Silicone Film Formers

**Advantages**

- Multiple types of film formers are available
- Oxygen / CO₂ / H₂O (TEWL) permeable
- Uniform films due to silicone spreadability
- Provide some level of water resistant / wash off resistant
  - In general, the higher molecular weight the better wash-off resistance
- Provide some level of transfer resistance
- Compatible with silicone and some non-silicone carriers
- Excellent application spreading
- Comfortable wear (light) and positive sensory feel
Trimethylsiloxy silicate Applications

- **Color Cosmetics**: Provide lasting wear and wash-off resistance in Foundations, Lip care, Mascaras.
- **Suncare**: Provide water resistance and transfer resistance.
- **Skin Care**: Creams Lotions, Insect repellents, Skin protectants where long last benefit and/or wash-off resistance is desired.
Trimethylsiloxy silicate Resins / Resin Blends

- Breathable film.
- High water repellency: Longer wear, wash-off resistance and water resistance. Some blends provide excellent transfer resistance.
- High sebum repellency, prevents pigment discoloration on skin.
- High molecular weight films are brittle and not flexible.
  - Higher molecular weight TMS resins are brittle and form aggregates upon volatile solvent evaporation (volatile silicones, IDD, etc.).
  - High molecular weight can be delivered in non-volatile silicones but the resulting film is liquid.
  - Low Molecular Weight TMS resins form sticky viscous liquid films and can transfer to other surfaces easily.
  - TMS resins do not form flexible films.
# Specsilk Trimethylsiloxy Silicate Resins

## 100% Resin Products

<table>
<thead>
<tr>
<th>Specsilk Grade</th>
<th>K-71*</th>
<th>K-72*</th>
<th>K-77</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Easy to Disperse Powder</td>
<td>Powder</td>
<td>Clear Viscous Liquid</td>
</tr>
<tr>
<td>Viscosity (cP)</td>
<td>NA</td>
<td>NA</td>
<td>2000</td>
</tr>
<tr>
<td>Refractive Index</td>
<td>~ 1.46</td>
<td>~ 1.46</td>
<td>1.46</td>
</tr>
<tr>
<td>Resin Solids</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Hard Resin</td>
<td>Brittle</td>
<td>Brittle</td>
<td>Soft Resin (Low MW)</td>
</tr>
<tr>
<td>Film type</td>
<td>Brittle</td>
<td>Brittle</td>
<td>Viscous Liquid</td>
</tr>
</tbody>
</table>

*K-71 and K-72 are the same grade but K-71 has a smaller particle size*

- Excellent water resistance and long wear resistance.
- 100% resins offer formulation flexibility to formulate resin into customer choice of carrier fluid
  - K-71 provides easier dispersability/solvation in cosmetic fluids.
  - K-77 is for easy handling and dispersion into cosmetic fluids. Has adequate water resistance properties in some applications.
# Trimethylsiloxydimethylsiloxane

**100% resin Products**

## Solubility in Common Cosmetic Ingredients

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Specsil Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K-71 / K-72</td>
</tr>
<tr>
<td>Diluent, None</td>
<td>None</td>
</tr>
<tr>
<td>Water, I</td>
<td>I</td>
</tr>
<tr>
<td>Ethanol (95%), I</td>
<td>I</td>
</tr>
<tr>
<td>Ethanol (99.5%), S</td>
<td>S</td>
</tr>
<tr>
<td>Dimethicone, S</td>
<td>S</td>
</tr>
<tr>
<td>Cyclopentasiloxane, S</td>
<td>S</td>
</tr>
<tr>
<td>Phenyl Trimethicone, S</td>
<td>S</td>
</tr>
<tr>
<td>Isododecane, S</td>
<td>S</td>
</tr>
<tr>
<td>Finsolv TN (C12-15 Alkyl Benzoate), I</td>
<td>S</td>
</tr>
<tr>
<td>Isopropyl myristate, S</td>
<td>S</td>
</tr>
<tr>
<td>Mineral Oil, I</td>
<td>I</td>
</tr>
<tr>
<td>Diisopropyl Adipate, I</td>
<td>I</td>
</tr>
<tr>
<td>Isocetyl Stearate, I</td>
<td>I</td>
</tr>
<tr>
<td>C12-15 Alkyl Lacate, I</td>
<td>I</td>
</tr>
<tr>
<td>Ethylhexyl Palmitate, I</td>
<td>I</td>
</tr>
<tr>
<td>Isostearyl Neopentanoate, S</td>
<td>S</td>
</tr>
</tbody>
</table>

S = Soluble  
I = Insoluble  

Testing based on 10% and 50% resin in cosmetic ingredient
# Specsil Trimethylsiloxyxysilicate Blends

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carrier</strong></td>
<td>Volasil® 995</td>
<td>Volasil® 990</td>
<td>Dimethicone</td>
<td>Isododecane</td>
<td>Dimethisil® DM-1.5</td>
<td>Dimethicone</td>
<td>Dimethicone</td>
<td>Dimethicone</td>
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<td><strong>Appearance</strong></td>
<td>Clear Liquid</td>
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<td>Clear Liquid</td>
<td>Clear Liquid</td>
<td>Clear Liquid</td>
<td>Clear Liquid</td>
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<tr>
<td><strong>Viscosity (cP)</strong></td>
<td>~200</td>
<td>~200</td>
<td>~5000</td>
<td>&lt; 50</td>
<td>~1200</td>
<td>~700</td>
<td>~500</td>
<td>4500</td>
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<td><strong>Refractive Index</strong></td>
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<td>~1.41</td>
<td>~1.41</td>
<td>1.42</td>
<td>~1.41</td>
<td>~1.41</td>
<td>~1.41</td>
<td>~1.41</td>
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<tr>
<td><strong>Resin Solids</strong></td>
<td>50%</td>
<td>50%</td>
<td>60%</td>
<td>50%</td>
<td>65%</td>
<td>40%</td>
<td>35%</td>
<td>50%</td>
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<td><strong>Film type</strong></td>
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<td>Visc. Liquid</td>
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<td>Brittle</td>
<td>Liquid</td>
<td>Liquid</td>
<td>Clear Flexible Film</td>
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<tr>
<td><strong>Major Feature</strong></td>
<td>Volatile Carrier</td>
<td>Volatile Carrier</td>
<td>K-77 Blend</td>
<td>Volatile Carrier</td>
<td>Volatile Carrier</td>
<td>Koboguard MQ65TMF</td>
<td>DC 593</td>
<td>SS-4267</td>
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<tr>
<td><strong>Offsets</strong></td>
<td>DC 749</td>
<td>DC 749</td>
<td>-</td>
<td>X-21-6696</td>
<td>-</td>
<td>DC 593</td>
<td>SS-4267</td>
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</table>

*Low D4 version of K-73*
## Solubility in Cosmetic Ingredients

<table>
<thead>
<tr>
<th>Cosmetic Ingredient</th>
<th>Specsil Grade (and its Diluent)</th>
<th>K-73 &amp; K-78 (D5)</th>
<th>K-74 (Dimethicone)</th>
<th>K-75 (IDD)</th>
<th>K-76 (DM-1.5)</th>
<th>K-79 (Dimethicone)</th>
<th>K-79 LV (Dimethicone)</th>
<th>K-80 (Dimethicone)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>S</td>
<td>I</td>
<td>I</td>
<td>L</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Ethanol (95%)</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>L</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Ethanol (99.5%)</td>
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<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Dimethicone</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
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<tr>
<td>Cyclopentasiloxane</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
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<td>S</td>
</tr>
<tr>
<td>Phenyl Trimethicone</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
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<tr>
<td>Isododecane</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Finsolv TN (C12-15 Alkyl Benzoate)</td>
<td>S</td>
<td>I</td>
<td>S</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Isopropyl myristate</td>
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<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Mineral Oil</td>
<td>L</td>
<td>I</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>L</td>
</tr>
<tr>
<td>Diisopropyl Adipate</td>
<td>S</td>
<td>S</td>
<td>L</td>
<td>L</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>L</td>
</tr>
<tr>
<td>Isostearyl Stearate</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>L</td>
<td>S</td>
<td>S</td>
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<td>L</td>
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<tr>
<td>C12-15 Alkyl Latcate</td>
<td>S</td>
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<td>S</td>
<td>L</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>L</td>
</tr>
<tr>
<td>Ethylhexyl Palmitate</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
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<td>L</td>
</tr>
<tr>
<td>Isostearyl Neopentanoate</td>
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<td>S</td>
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<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>L</td>
</tr>
</tbody>
</table>

S = Soluble  
I = Insoluble  
L = Limited amounts (not soluble at 50/50 ratio)  
Testing based on 10% and 50% test ingredient in resin blend
Specsil Trimethylsiloxy silicate Blends

Specsil K-78
Cyclopentasiloxane and Trimethylsiloxy silicate

Physical Properties:
- **Color**: Sl. Yellow to Colorless
- **Odor**: Typical resin odor
- **Appearance**: Sl. Hazy to Clear Liquid
- **Viscosity@25°C (4, 20 rpm)**: ~ 200 cps
- **Refractive Index**: ~ 1.41
- **Carrier**: Low D4 (< 0.1%) Cyclopentasiloxane

- Same as K-73 but with low D4 content.
- Volatile carrier and good compatibility with organic ingredients such as hydrocarbon solvents, organic esters and anhydrous ethanol.
- Dried film on the skin has good comfort of wear and is breathable.
- Water resistant, rub-off resistant and sebum resistant.
- Good compatibility with organic esters, anhydrous ethanol.
- Off-set to Dow Corning 749 & Momentive SS4230.
Specsil Trimethyloxydimethylsiloxane Blends

Specsil K-76
Dimethicone and Trimethylsiloxydimethylsiloxane

Physical Properties:

- **Color**: Slightly Yellow to Colorless
- **Odor**: Typical resin odor
- **Appearance**: Slightly Hazy to Clear Liquid
- **Viscosity at 25°C (4, 20 rpm)**: ~ 1200 cps
- **Refractive Index**: ~ 1.41
- **Carrier**: Volatile Dimethicone

- Cyclic-free volatile carrier, Volasil® DM-1.5.
- Dried film on the skin has good comfort of wear and is breathable.
- Water resistant, rub-off resistant and sebum resistant.
- Off-set to Koboguard MQ65TMS.
Specsil Trimethylsiloxy-silicate Blends

Specsil K-79

Dimethicone and Trimethylsiloxy-silicate

Physical Properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Sl. Yellow to Colorless</td>
</tr>
<tr>
<td>Odor</td>
<td>Typical resin odor</td>
</tr>
<tr>
<td>Appearance</td>
<td>Sl. Hazy to Clear Liquid</td>
</tr>
<tr>
<td>Viscosity@25°C (4, 20 rpm)</td>
<td>400 - 1000 cps</td>
</tr>
<tr>
<td>Refractive Index</td>
<td>~ 1.41</td>
</tr>
<tr>
<td>Carrier</td>
<td>Dimethicone</td>
</tr>
</tbody>
</table>

- Non-volatile carrier that produces clear liquid films.
- Dried film on the skin has good comfort of wear and is breathable.
- Rub, water, wash-off and sebum resistant.
- Compatible with many organic esters.
- Off-set to Dow Corning 593.
Specsil Trimethylsiloxyasilicate Blends

Specsil K-79 LV
Dimethicone and Trimethylsiloxyasilicate

Physical Properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Sl. Yellow to Colorless</td>
</tr>
<tr>
<td>Odor</td>
<td>Typical resin odor</td>
</tr>
<tr>
<td>Appearance</td>
<td>Sl. Hazy to Clear Liquid</td>
</tr>
<tr>
<td>Viscosity@25°C (4, 20 rpm)</td>
<td>300 - 700 cps</td>
</tr>
<tr>
<td>Refractive Index</td>
<td>~ 1.41</td>
</tr>
<tr>
<td>Carrier</td>
<td>Dimethicone</td>
</tr>
</tbody>
</table>

- Non-volatile carrier that produces clear liquid films.
- Dried film on the skin has good comfort of wear and is breathable.
- Rub, water, wash-off and sebum resistant.
- Compatible with many organic esters.
- Off-set to Momentive SS-4267.
Specsil Trimethylsiloxyssilicate Blends

Specsil K-80
Dimethicone and Trimethylsiloxyssilicate

Physical Properties:

- **Color**: Sl. Yellow to Colorless
- **Odor**: Typical resin odor
- **Appearance**: Sl. Hazy to Clear Liquid
- **Viscosity@25°C (4, 20 rpm)**: ~ 4500 cps
- **Refractive Index**: ~ 1.41
- **Carrier**: Volatile Dimethicone

- Volatile carrier.
- Clear smooth flexible films, no visible stress cracks.
- Dried film on the skin has good comfort of wear and is breathable.
- Rub, water, wash-off and sebum resistant.
- **Innovative new product.**
Before K-80: 4% Color Reduction

Film draw downs were prepared on a Leneta cards using a 10 gauge wire. Films were allowed to dry for 48 hours.

• (1) gives areas of localised crystallisation and loss of adhesion.
• (2) gives a ‘beaded’, uneven profile due to poor wetting and spreading, and also crystallisation after drying.
• (3) and Specsil K-80 give crystal clear, flexible shiny films.
• K-80 is an Innospec innovation and is more cost effective than the market leading acrylate/dimethicone crosspolymer.

Specsil K-80 – A Novel Flexible Film Former
Film Former Film Comparisons
<table>
<thead>
<tr>
<th>Dry Film</th>
<th>Dry Film Imaging</th>
<th>Dry Film Post Flexing</th>
<th>Post Flexing Imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Specsil K-80" /></td>
<td><img src="image2" alt="Specsil K-80" /></td>
<td><img src="image3" alt="Specsil K-80" /></td>
<td><img src="image4" alt="Specsil K-80" /></td>
</tr>
<tr>
<td><img src="image5" alt="Specsil K-80" /></td>
<td><img src="image6" alt="Specsil K-80" /></td>
<td><img src="image7" alt="Specsil K-80" /></td>
<td><img src="image8" alt="Specsil K-80" /></td>
</tr>
</tbody>
</table>

- Photos show pre-flexing and post flexing of the films created on Leneta cards.
- Imaging (highlighted red areas) shows re-crystallisation of the trimethylosiloxysilicate resin occurs when delivered from a volatile solvent.
- Imaging also shows the brittleness and fragility of the trimethylosiloxysilicate after flexing when delivered from a volatile solvent.
- However, no re-crystallisation or fragility is apparent with both the Acrylate/dimethicone Crosspolymer and **Specsil K-80** after flexing, showing excellent film flexibility.
Specsil K-80
Film Flexibility from a Different Angle

- Market leading Cyclopentasiloxane (and) Trimethylsiloxy silicate shows stress cracking.
- Market leading Cyclopentasiloxane (and) Acrylate/dimethicone Crosspolymer and Specsil K-80 show even films with no stress cracking.
Specsil K-80
Film Properties: Mar Resistance Comparison

Using the stylus from the coefficient of friction kit, mar resistance was determined on the different films using different weight forces.

The film from the Cyclopentasiloxane (and) Trimethylsiloxy silicate (F = 50g) was not mar resistant at the lowest amount of force applied (50g).

The film from Cyclopentasiloxane (and) Acrylate/dimethicone Crosspolymer (F = 500g) was not mar resistant with 500g of force applied.

The Specsil K-80 film was found to be mar resistant even at 500g of force applied.
Specsil K-80
Wash-Off Resistance Comparison

- Aqueous solution of Blue 1 dye applied to skin.
- Left to dry for 30 minutes.
- 50 microliters of test product applied.
- Left to dry for 30 minutes.
- Washing of treated and untreated areas to a standard protocol.
- Color reduction measured with a Minolta Colorimeter.

Market leading Cyclopentasiloxane (and) Acrylate/dimethicone Crosspolymer

Market leading Cyclopentasiloxane (and) Trimethylsiloxysilicate

Specsil K-80

Before washing
Treated  Untreated

After washing
Treated  Untreated

8% Colour reduction

Specsil K-80 at 50% dilution (30% solids)

Before washing
Treated  Untreated

After washing
Treated  Untreated

5% Colour reduction

Before washing
Treated  Untreated

After washing
Treated  Untreated

2% Colour reduction

44% Colour reduction
Thank you for listening!
Any questions?

tony.gough@innospecinc.com