Silicone Technology for Adhesion not just for Release!

RUBBER ADHESION
LONDON  7 April 2017
Agenda

- About Dow
- Silicone Technology Overview
- Release Coatings
  - Technology
- Silicone Adhesives
  - Market Trends
  - Technology
- Conclusions
- Summary
Dow is now 100 percent owner of Dow Corning’s silicones business.

- Long histories of innovation and technology leadership
- Strong customer focus
- Dow Corning’s silicones fully aligned to Dow’s portfolio strategy
- A commitment to:
  - Sustainability
  - Solving global challenges
  - Advancing community success
Silicone Technology
What are Silicones?

Silicones are quite UNUSUAL polymers in that they are not ‘stiff’ like most organic polymers. Highly flexible, due to complete rotational freedom about each Si-O bond.

R= Mostly Methyl groups- CH₃
Silicones are very well known as Release Coatings for Organic Pressure Sensitive Adhesives (PSAs)
Release Coating Technology
Anatomy of a Release Coating

Cure mechanism is also used for one class of silicone pressure sensitive adhesive
Release Coating Technology for PSAs
What is unusual about Silicones?

1. FLEXIBILITY
Silicones are highly flexible polymers.

2. SURFACE ENERGY
Silicones have a low surface energy (but this alone does not explain release).
Mechanism of Release

Why Silicones Release

Crack propagation

Limited viscoelastic dissipation

Polymer ONLY Network. Stressed silicone polymers at interface collapse (easily move), the crack propagates easily - easy release.
Silicone Pressure Sensitive Adhesive Technology
Why Silicone Pressure Sensitive Adhesives?

- Si-O flexibility, longer chain length, and bond angles leads to:
  - Sticks to low energy surfaces
  - Ability to reposition
  - Minimal Property change over a wide temperature range

- Si-O stability leads to:
  - High temperature performance stability
  - UV stability

<table>
<thead>
<tr>
<th>Siloxane Polymer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Me</td>
</tr>
<tr>
<td>OH</td>
</tr>
<tr>
<td>Me</td>
</tr>
</tbody>
</table>

\[ R = \text{(methyl, phenyl, alkyl, OH, vinyl, etc...)} \]
Why Silicones Instead of Organic PSAs?

<table>
<thead>
<tr>
<th>Advantages Typical of Silicones</th>
<th>Disadvantages Typical of Silicones</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Wide temperature range capabilities</td>
<td>• Poor solvent resistance</td>
</tr>
<tr>
<td>• Moisture/UV resistance</td>
<td>• Low adhesive strength</td>
</tr>
<tr>
<td>• Adhesion to low energy surfaces</td>
<td>• Low tack</td>
</tr>
<tr>
<td>• Conformability</td>
<td></td>
</tr>
<tr>
<td>• Clean removability</td>
<td></td>
</tr>
<tr>
<td>• Electrical insulation properties</td>
<td></td>
</tr>
<tr>
<td>• Sound-dampening characteristics</td>
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</table>
## Silicone-PSA Advantage

<table>
<thead>
<tr>
<th>Typical Properties</th>
<th>Silicone PSA</th>
<th>Organic PSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type (Cure/Material)</td>
<td>Addition</td>
<td>BPO</td>
</tr>
<tr>
<td>Heat Resistance</td>
<td>200-250°C</td>
<td>250-300°C</td>
</tr>
<tr>
<td>Lower Temp. Resistance</td>
<td>-50°C</td>
<td>-50°C</td>
</tr>
<tr>
<td>Weather Resistance</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>Adhesion to PTFE</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Adhesion to Si Rubber</td>
<td>Middle to High</td>
<td>High</td>
</tr>
</tbody>
</table>
Silicone PSA Components

- Resins
- Polymers
- Solvents
- Cross-linkers (for Pt system)
- Catalyst
Silicone PSA Compositions

Silicone Polymer

R1= (OH, vinyl, alkyl, phenyl, etc.)
R2= (methyl, phenyl, alkyl, vinyl, etc.)
Silicone PSA Compositions - Resin

Silicate Tackifier Resin

\[
\begin{align*}
\text{OH} & \\
\text{Me} - \text{Si} - \text{Me} & \\
\text{Me} & \\
\text{Me} - \text{Si} & \\
\text{Me} - \text{Si} - \text{Me} & \\
\text{Me} & \\
\text{OH} & \\
\end{align*}
\]
Silicone PSA Compositions – Other Components

Solvent
• Toluene or Xylene

Catalyst
• BPO or Pt
Cure Mechanism of BPO Cure PSA
(BPO: benzoyl peroxide)

1. \( \frac{\text{PhO}}{\text{PhO}} \xrightarrow{\Delta} \text{PhO} \cdot \)  
2. \( \text{PhO} \cdot + \equiv \text{SiCH} \rightarrow \text{PhO} - \text{H} + \equiv \text{SiCH} \cdot \)  
3. \( \equiv \text{SiCH} \cdot + \equiv \text{SiCH} \cdot \rightarrow \equiv \text{SiC-C-Si} \equiv \)

- Drive Off Solvent at 70°C 1st Step – 1-2 minutes
  - Residual Solvent can react with BPO, causing bubble formation.
- Cure 180-204°C 2nd Step 1-2 minutes
Cure Mechanism of Addition Cure PSA

- Cure in 1 step
- 100-150°C for 1-2 minutes
## Cure System Comparison

<table>
<thead>
<tr>
<th>Peroxide Cure</th>
<th>Addition Cure</th>
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</thead>
<tbody>
<tr>
<td>• Must be cured at high temp</td>
<td></td>
</tr>
<tr>
<td>• Very good high temp props</td>
<td></td>
</tr>
<tr>
<td>• Good tack and adhesion</td>
<td></td>
</tr>
<tr>
<td>• Often requires priming</td>
<td></td>
</tr>
<tr>
<td>• Not easily poisoned</td>
<td></td>
</tr>
<tr>
<td>• Can be cured at low temp</td>
<td></td>
</tr>
<tr>
<td>• Good high temp props</td>
<td></td>
</tr>
<tr>
<td>• Good tack/adhesion Low tack for some applications.</td>
<td></td>
</tr>
<tr>
<td>• May not require priming</td>
<td></td>
</tr>
<tr>
<td>• Easily poisoned</td>
<td></td>
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</tbody>
</table>
Where are Silicone PSA’s Used?

Electronics
Protective Tapes/Films
Pressure Sensitive Converting
General Industrial Processing
Automotive
Aerospace
Medical and Healthcare
Electronic Masking Tapes

Applications
- Circuit Board Masking for Metal Plating
- Etching & Soldering Bath Operations

Backings
- Polyester
- Polyimide
- PTFE

Performance Needs
- Conformability
- Chemical & Temperature Resistance
- Clean Removability
- Low Migration
Protective Tapes/Films

Applications
- Electronics/Electrical Protective Tape; Carrier Tape; LCD; Polarizing; Prism Film; Diffuser Metal Protective Film

Backing
- Polyester; Polyimide; PE
- High Temperature Resistance; Low Adhesion; Stable Adhesion; Low Migration; Clean Removability; Excellent Wettability

Performance Needs

Market Need
- Anti-Scratch
Surface Wetting

• Unintentional bubble entrapment - Ability to move bubbles to edge

• Fast wetting time to substrate – faster with lower adhesion Si PSA Types
Splicing Tapes

**Applications**
- Splicing and Bonding of Lower Surface Energy Substrate/Film/Board etc… in High Temperature, Chemical, Solvent Etching Process, During High Speed Continuous Process

**Backings**
- PET

**Performance Needs**
- High Adhesion to Low Energy Surfaces
- Quick Stick/High Tack for Flying Splices
# Adhesive Application Types

<table>
<thead>
<tr>
<th>Types</th>
<th>Adhesion Range</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra Low Adhesion</td>
<td>0.5-4 grams/inch</td>
<td>Protective Tapes for Display mfg process, Mobile &amp; Display surfaces</td>
</tr>
<tr>
<td>Very Low Adhesion</td>
<td>5-10 grams/inch</td>
<td>Processing Tape in Mobile Assembly</td>
</tr>
<tr>
<td>Low Adhesion</td>
<td>20-100 grams/inch</td>
<td>Masking tape for F-PCB, Casting</td>
</tr>
<tr>
<td>Moderate Adhesion</td>
<td>100-300 grams/inch</td>
<td>Removal tape</td>
</tr>
<tr>
<td>High Adhesion</td>
<td>300-2000 grams/inch</td>
<td>Bonding tape, Masking tape for PCB</td>
</tr>
</tbody>
</table>
Pressure Sensitive Adhesives

Syl-Off® Fluorosilicone Release Coatings

Consistent, stable, low-force release

Used for transfer films, labels, industrial tapes and double-sided tapes
Si Tape Manufacturing Process

Self Wound Tape
- Silicone PSA
- PET Film

Double Sided Tape
- Liner
- Adhesive
- Carrier

Single Sided Tape
- Liner
- Adhesive
- Carrier

Unsupported or Lamination Tape
- Fluoro Liner
- Silicone PSA
- FluoroLiner
Summary
Silicones for Adhesion
Summary: Technology Advances

Silicone PSAs are used when:

- The end-use environment has special needs or extremes in which a typical organic would fail.
- Adhesion to low surface energy materials is needed.
- Clean Removability is desired.
Please Visit Us

dowcorning.com/psi
Thank You

DOW CORNING

Pressure Sensitive Solutions