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An Instant Bond: Silicone Reactive Hot Melt for Plastics

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What We’ll Discuss

1. 100% Silicone Reactive Hot Melt
   - Mechanical properties
     - Instant bonding
     - Energy dissipation
     - Low VOC
   - Features and benefits
     - Unprimed adhesion
     - Temperature resistance
     - Weather resistance / durability
     - Stress strain
     - Elastic recovery

2. Cost Savings
   - Manufacturing efficiency
   - Reduced material waste
   - Extended performance life

3. Expanding Applications
   - Plastic bonding applications
   - Replacement for mechanical fasteners
100% Silicone* Reactive Hot Melt

* Silicone is a non-organic (carbon-based) polymer backbone
## Comparison of Bonding Techniques

<table>
<thead>
<tr>
<th>Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Tape</td>
<td>• Inexpensive&lt;br&gt;• No equipment necessary</td>
<td>• Labor intensive&lt;br&gt;• No automated application&lt;br&gt;• Application consistency (manual)&lt;br&gt;• Primer often needed on low surface energy plastics</td>
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<tr>
<td>Traditional Sealants</td>
<td>• Moderate-to-superior performance &amp; reliability&lt;br&gt;• Low cost application equipment</td>
<td>• Poor green strength&lt;br&gt;• Material squeeze-out&lt;br&gt;• Surface contamination</td>
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<tr>
<td>Mechanical Fasteners</td>
<td>• Long term bond</td>
<td>• Drilled holes weaken material and can lead to stress points&lt;br&gt;• Temperature variations induce high stress at screw points</td>
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<tr>
<td>Silicone Reactive Hot Melt</td>
<td>• Instant bonding&lt;br&gt;• Accelerated production process&lt;br&gt;• Lowers labor costs&lt;br&gt;• Design flexibility&lt;br&gt;• Strong adhesion to plastics</td>
<td>• Initial equipment investment&lt;br&gt;• Higher material costs</td>
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Mechanical Properties

Stress Strain

- Behaves like a high modulus elastomer at low temperature or high strain rate
- Behaves like a low modulus elastomer at high temperature or under constant load
Mechanical Properties

The elastic component $G'$ is a measure of the ability to store energy and to recover when deformation ceases.

The viscous component $G''$ is a measure of the ability to dissipate the energy being applied.

The dynamic loss tangent, $\tan \delta$, is the ratio of $G''$ to $G'$. The breadth and magnitude of $\tan \delta$ is responsible for the adhesive performance over a wide range of frequencies and temperatures; balancing energy dissipation (adhesive) and energy storing (strength) capabilities.

The dynamic modulus, $G''$, and $G'$ are shown as a function of frequency at different temperatures. The elastic component $G'$ increases with frequency at low temperatures, indicating energy storage, while the viscous component $G''$ shows a peak at a specific frequency and temperature, indicating energy dissipation.

High temperature behavior: Long-term (slow rate) properties
Low temperature behavior: Short-term (high rate) properties

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90 25

Viscoelastic function
○ ○ Storage modulus $G'$; elastic component
□ □ Loss modulus $G''$, loss/viscous component
△ △ Loss tangent, $\tan \delta$ ($G''/G'$)
Mechanical Properties

Elastic Recovery

The cycling under a constant deformation shows that an elastic recovery greater than 90% is retained over more than 3 days thereby providing this hot melt with excellent movement capability resulting in less stress buildup.
Features and Benefits

Unprimed Adhesion

- Very low surface tension → excellent wetting characteristics even on non-polar substrates such as polyethylene or polypropylene
- Low elastic modulus → a material of choice for sealing plastics to materials with different CTEs such as glass, plastics and metals

Temperature Resistance

- Chemical bond unaffected by typical high and low temperature conditions
- Service temperatures of -50°F (-45°C) to 300°F (150°C)

Weather Resistance / Durability

- Unaffected by long term direct and indirect UV exposure
- The silicone reactive hot melt is resistance to water
Cost Savings

Manufacturing Efficiency

- Fast bonding
  - Rapid rise in viscosity
  - Pressure sensitive adhesive (PSA) character of the material
- No need for priming or surface activation; including plastics, glass, PVC, wood, paints and aluminum
- Easy to process using automatic equipment
- Increases production rates in assembly manufacturing

<table>
<thead>
<tr>
<th>Shear Strength vs. Cure Time</th>
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<tbody>
<tr>
<td>Adhesive</td>
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<tr>
<td>-----------------------------</td>
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<tr>
<td>Silicone reactive hot melt</td>
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<tr>
<td>Silicone sealant</td>
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<tr>
<td>Bonding tape #1</td>
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<tr>
<td>Bonding tape #2</td>
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</table>
Cost Savings

Reduced Material Waste
- 24-hour pot life
- Reduces squeeze out
- Improves beading consistency
- 15-minute open time to adjust materials being set

Extended Performance Life
- Reduces sealant failure → reduced part replacement
- Reduces total cost of ownership
Expanding Applications
Assembly Trends

- Improve productivity
- Reduce labor costs
- Improve reliability
- Eliminate need for penetrating fasteners
- Increase heat stability
- Allowing bonding of differing materials
Expanding Applications

Plastic Bonding
- Silicone hot melts bond readily to plastics
  - Polyethylene, polycarbonate, polypropylene, acrylic
- Provides a flexible seal that withstands differing thermal expansion coefficients
- Reduces stress on bond line with low elastic modulus

Replacement for Mechanical Fasteners
- Bonds more completely than mechanical fasteners
- More durable over time
- Low stress point cracking
- Absorbs stress from thermal expansion
Expanding Applications

- Sports & Leisure
- Home Appliance
- Industrial Applications
- Automotive Headlamps
- Solar Cells
- PC Boards
Summary

Takeaway #1:
Silicone reactive hot melts have the mechanical properties, adhesion performance and temperature resistant characteristics required to support an expanding range of applications, including plastic bonding and replacement of mechanical fasteners.

Takeaway #2:
Silicone reactive hot melt supports higher-speed assembly to increase manufacture output while reducing maintenance costs.
For more information…

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