Meet Your Presenters…

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Agenda

1. Who is Henkel?
2. Benefits of Adhesive Bonding
3. Application Examples
4. Adhesive Technology Review
5. Substrate Surface Preparation
6. Equipment & Additional Resources
7. Questions
Agenda

1. Who is Henkel?
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7. Questions
Who we are
Global leading positions in consumer and industrial businesses

Consumer Businesses
Laundry & Home Care

Industrial Business
Adhesive Technologies

Beauty Care

- Persil
- Purex
- Pril
- Schwarzkopf
- Dial
- Syoss
- Loctite
- Pritt
- Technomelt
Who we are
Henkel at a glance 2015

Almost
50,000
employees worldwide

€2.9 bn
adjusted¹ operating profit (EBIT)

Around
€18.1 bn
sales,
+3.0% organic sales growth

43%
of our sales generated in emerging markets

61%
of our sales generated by our top 10 brands

139 years
of brand success

¹ Adjusted for one-time charges/gains and restructuring charges.
Adhesive Technologies
Business units

Business Units
- General Industry
- Packaging & Consumer Goods
- Automotive & Metals
- Aerospace
- Electronics
- Consumer & Craftsmen

Top Brands

Loctite Webinar Series
Adhesive Technologies
Leading solution provider in adhesives, sealants & functional coatings

Customer Partnership

- Deep industry expertise
- Leading brands for industrial customers and consumers
- Best-in-class quality and service
- Global presence and customer proximity

Innovation Leader

- Comprehensive portfolio of leading technologies
- Innovation driver in the industry
- Shaping industry megatrends (e.g. sustainability, lightweight)
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Benefits of Adhesive Bonding

**Benefits**

- Distribute Stress Evenly

![Riveted Joint](image1)

![Adhesive Bond](image2)
Benefits of Adhesive Bonding

Benefits

• Distribute Stress Evenly
• Fill Large Gaps
Benefits of Adhesive Bonding

Benefits

• Distribute Stress Evenly
• Fill Large Gaps
• Seal, Bond and Protect
Benefits of Adhesive Bonding

Benefits

• Distribute Stress Evenly
• Fill Large Gaps
• Seal, Bond and Protect
• Easily Automated
Benefits of Adhesive Bonding

**Benefits**

- Distribute Stress Evenly
- Fill Large Gaps
- Seal, Bond and Protect
- Easily Automated
- Neat Appearance

**Before**

**After**
Benefits of Adhesive Bonding

Benefits

• Distribute Stress Evenly
• Fill Large Gaps
• Seal, Bond and Protect
• Easily Automated
• Neat Appearance
• Join Dissimilar Substrates

Metal to Glass

Zinc Dichromate to ferrite
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Application Examples
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# Adhesive Properties

## Uncured
- Viscosity
- Appearance
- Odor
- Extrusion Properties
- Sag
- Shelf Life

## Curing
- Fixture Time
- Tack Free Time
- Working Life
- Gel Time/Pot Life
- Exotherm
- Cure Through Depth

## Cured
- Shear Strength
- Hardness (Durometer)
- Mechanical Properties (tensile, elongation, modulus)
- Glass Transition Temp (Tg)
- Resistance (environmental, thermal, chemical, moisture, etc)
Adhesive Technology Review

**Instant Adhesives**
- Cyanoacrylates
- Light Cure

**Structural Bonding**
- Epoxies
- Acrylics
- Polyurethanes

**Elastomerics**
- Silicones
- Flextec®

**Machinery Adhesives**
- Anaerobics

**Bulk Adhesives**
- Hot Melts

8/3/2016
## Performance Considerations

### Adhesive Category

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Cyanocrylates</th>
<th>Epoxies</th>
<th>Hot Melts</th>
<th>Light Cure</th>
<th>Silicones</th>
<th>Elastomers</th>
<th>Urethanes</th>
<th>2-Part Acrylics</th>
<th>2-Step Acrylics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wide range of bonding applications/ ease of use</td>
<td>Wide range of formulations</td>
<td>Versatile, fast, large gap filling</td>
<td>Rapid cure/ adhesion to plastics/ bond on demand</td>
<td>Excellent temperature resistance</td>
<td>Flexible, paintable, border/ sealant</td>
<td>Excellent toughness/ flexibility</td>
<td>Good impact resistance/ flexibility</td>
<td>Good impact resistance/ no-mix</td>
</tr>
<tr>
<td>Limitations</td>
<td>Low polar solvent resistance</td>
<td>Mixing required</td>
<td>Limited heat resistance</td>
<td>Light cure required</td>
<td>Low adhesion resistance</td>
<td>High temperature resistance</td>
<td>Sensitive to moisture</td>
<td>Mixing required</td>
<td>Primer required</td>
</tr>
<tr>
<td>Temperature Resistance</td>
<td>Typical for the category:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-65°F to 210°F (-54°C to 99°C)</td>
<td>-65°F to 180°F (-54°C to 82°C)</td>
<td>-65°F to 250°F (-54°C to 121°C)</td>
<td>-65°F to 300°F (-54°C to 149°C)</td>
<td>-65°F to 400°F (-54°C to 204°C)</td>
<td>-65°F to 200°F (-54°C to 93°C)</td>
<td>-65°F to 250°F (-54°C to 121°C)</td>
<td>-65°F to 250°F (-54°C to 121°C)</td>
<td>-65°F to 300°F (-54°C to 149°C)</td>
</tr>
<tr>
<td>Highest rated product</td>
<td>250°F (121°C)</td>
<td>400°F (204°C)</td>
<td>330°F (166°C)</td>
<td>358°F (180°C)</td>
<td>725°F (385°C)</td>
<td>200°F (93°C)</td>
<td>300°F (149°C)</td>
<td>250°F (121°C)</td>
<td>400°F (204°C)</td>
</tr>
<tr>
<td>Environmental Resistance</td>
<td>Polar solvents (EX: H₂O, Ethylene Glycol, Isopropyl Alcohol (IPA), Acetone)</td>
<td>Poor¹</td>
<td>Very Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>Nonpolar Solvents (Ex. Motor Oil, Toluene, Gasoline, ATF)</td>
<td>Good</td>
<td>Excellent</td>
<td>Good</td>
<td>Very Good</td>
<td>Poor to Fair</td>
<td>Poor</td>
<td>Good</td>
<td>Very Good</td>
</tr>
<tr>
<td>Adhesion to Substrates</td>
<td>Metals</td>
<td>Very Good</td>
<td>Excellent</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Very Good</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>Plastics²</td>
<td>Excellent</td>
<td>Fair</td>
<td>Very Good</td>
<td>Excellent</td>
<td>Fair</td>
<td>Good</td>
<td>Very Good</td>
<td>Excellent</td>
</tr>
<tr>
<td></td>
<td>Glass</td>
<td>Poor</td>
<td>Excellent</td>
<td>Good</td>
<td>Excellent</td>
<td>Very Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>Rubber</td>
<td>Very Good</td>
<td>Fair</td>
<td>Fair</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td></td>
<td>Wood</td>
<td>Good</td>
<td>Very Good</td>
<td>Excellent</td>
<td>Poor</td>
<td>Fair</td>
<td>Very Good</td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>Overlapping Shear Strength</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Peel Strength</td>
<td>Low²</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Tensile Strength</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Elongation/ Flexibility</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Hardness</td>
<td>Rigid</td>
<td>Rigid</td>
<td>Semisoft</td>
<td>Semirigid</td>
<td>Soft</td>
<td>Soft</td>
<td>Soft</td>
<td>Semirigid</td>
</tr>
</tbody>
</table>
## Process Considerations

<table>
<thead>
<tr>
<th>Adhesive Category</th>
<th>Cyanoacrylates</th>
<th>Epoxies</th>
<th>Hot Melts</th>
<th>Light Cure</th>
<th>Silicones</th>
<th>Elastomers</th>
<th>Urethanes</th>
<th>2-Part Acrylics</th>
<th>2-Step Acrylics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Components</td>
<td>1 or 2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1 or 2</td>
<td>1 or 2</td>
<td>1 or 2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Cure Temperature</td>
<td>Room temperature</td>
<td>Room temperature</td>
<td>Room temperature</td>
<td>UV/ Visible</td>
<td>Room temperature</td>
<td>Room temperature</td>
<td>Room temperature</td>
<td>Room temperature</td>
<td>Room temperature</td>
</tr>
<tr>
<td>Fixture Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>30 seconds</td>
<td>20 minutes</td>
<td>70 seconds</td>
<td>30 seconds</td>
<td>25 minutes</td>
<td>25 minutes</td>
<td>25 minutes</td>
<td>20 minutes</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Fastest</td>
<td>&lt;5 seconds</td>
<td>3 to 5 minutes</td>
<td>20 seconds</td>
<td>&lt;5 seconds</td>
<td>2 minutes</td>
<td>10 minutes</td>
<td>5 minutes</td>
<td>3 to 5 minutes</td>
<td>30 seconds</td>
</tr>
<tr>
<td>Full Cure Time</td>
<td>24 hours</td>
<td>12 to 24 hours</td>
<td>1 hour (or when cooled)</td>
<td>30 to 60 seconds</td>
<td>1 to 7 days</td>
<td>1 to 7 days</td>
<td>24 hours</td>
<td>24 hours</td>
<td>24 hours</td>
</tr>
<tr>
<td>Gap Fill</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ideal (in inches)</td>
<td>0.001 to 0.010</td>
<td>0.004 to 0.006</td>
<td>0.002 to 0.005</td>
<td>0.002 to 0.010</td>
<td>0.001 to 0.006</td>
<td>0.001 to 0.006</td>
<td>0.004 to 0.006</td>
<td>0.010 to 0.040</td>
<td>0.002 to 0.004</td>
</tr>
<tr>
<td>Maximum (in inches)</td>
<td>0.200</td>
<td>0.125</td>
<td>0.240</td>
<td>0.25</td>
<td>0.25</td>
<td>0.24</td>
<td>0.125</td>
<td>0.5</td>
<td>0.40</td>
</tr>
<tr>
<td>Dispensing/Mixing Equipment Required</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Light Cure Versions Available</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
## Adhesive Selection

### Substrate

<table>
<thead>
<tr>
<th>Substrates</th>
<th>Options to Eliminate/Avoid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic substrate</td>
<td>Avoid Anaerobics, Silicones, Epoxies</td>
</tr>
<tr>
<td>Glass</td>
<td>Eliminate CAs and Anaerobics</td>
</tr>
<tr>
<td>No transparent surfaces</td>
<td>Eliminate Light Cure</td>
</tr>
<tr>
<td>No metal substrates</td>
<td>Eliminate Anaerobics</td>
</tr>
</tbody>
</table>

8/3/2016

Bonding Dissimilar Substrates -- Loctite Webinar Series
Adhesive Selection

Joint Design

• Maximize These Forces
  • Shear, Tension & Compression

• Minimize These Forces
  • Peel, Cleavage Forces

• Minimize Gap Thickness

• Increase Bond Area
  • Wider Is Better Than Overlap

• Use the Appropriate Test to Qualify Your Adhesive
Adhesive Selection
Production Rate & Quality

- If Fast Rate (> 1 part per minute)
  - Try Hot Melts, CAs & Light Cure
- Choose equipment that fits speed of line
- If operator variability is a concern, stay away from manual application
Summary

- Joint Design is #1
- 2 Major Selection Criteria
  - Performance Considerations
  - Processing Considerations
  - REFER to the Adhesive SourceBook
- Technical resources are available to aid in adhesive selection
  - Plastic, Rubber, and Metal Bonding Guides
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Surface Preparation

Ideal Surface
• Clean
• Dry
• Rough

Minimal Wetting

Ideal Wetting
Surface Preparation  
Importance of cleaning

Adhesives bond to the surface

Substrate 1

Contaminant

Substrate 2

Adhesive molecule

Adhesion

Cohesion

Any contaminants reduce bonding strength
Surface Preparation
Origins of contaminants

• Machining
• Protecting
• Handling
• Washing / cleaning
• Manufacturing (e.g. mold release agents)
• From the material itself
• Surroundings
• Etc.
Surface Wetting Effects on Surface Energy

Surface Energy (dynes/cm)

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Initial Surface Energy</th>
<th>Surface Energy Following Plasma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polypropylene</td>
<td>29</td>
<td>&gt; 73</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>31</td>
<td>&gt; 73</td>
</tr>
<tr>
<td>PTFE, FEP</td>
<td>22 – 37</td>
<td>72 – 73</td>
</tr>
<tr>
<td>Polycarbonate</td>
<td>46</td>
<td>&gt; 73</td>
</tr>
<tr>
<td>Polysulfone</td>
<td>41</td>
<td>&gt; 73</td>
</tr>
<tr>
<td>Silicone</td>
<td>24</td>
<td>&gt; 73</td>
</tr>
<tr>
<td>Polyurethane</td>
<td>38</td>
<td>&gt; 73</td>
</tr>
</tbody>
</table>

Source: GaSonics International Plasma Corp.
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AG Equipment Resources

- Equipment Website – equipment.loctite.com
- Technical Repository
- E-Commerce
- Product Information

- Equipment Services – rental/loaners, spare parts, calibrations, repairs, warranty and technical support, etc.
- 1-800-LOCTITE
- Equipment.services @Henkel.com

- Equipment Sourcebook
Henkel Adhesive Resources

- www.Loctite-success.com
- na.henkel-adhesives.com/oem
- The Adhesive Sourcebook
- Plastic, Rubber and Metal Bonding Guides
- Application assistance
  - 1-800-LOCTITE (562-8483)
    - Over-the-phone assistance
      - Technical Information Services team
        - 8 a.m.-5 p.m. Eastern time
      - In-person assistance
        - Local Adhesive & Sealant Specialists
- Technical Customer Service department
  - Testing services
  - Process development
- Authorized Loctite Industrial Products Distributors
  - ~ 5,000 branches in USA

8/3/2016
Bonding Dissimilar Substrates -- Loctite Webinar Series
www.Loctite-success.com
General Intro to the Advantages of Adhesives

- Customer Success Stories & Videos
- Solutions Guide
- Adhesive Testing Lab Information & Videos
- Information on Additional Webinars
- Contact Us
The Adhesive Sourcebook
- Product Categories
- Market Segments
- Equipment Website
- Plastic, Rubber and Metal Bonding Guides
- Product Search
- TDS, MSDS & RoHS
- Buy Now
- How-to videos
- Literature, Case Histories, Quality Certifications & Additional Resources
- OEM Blog
Why Henkel?
Adhesive supplier considerations

- Breadth & depth of product offering
- Technical service / support
- Quality standards / industry certifications
- Testing capabilities
- Global reach and resources
- Process knowledge / dispensing equipment
- Industry expertise / innovativeness
- Overall value of offering
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