MATERIALS FOR
WEARABLE ELECTRONICS

Henkel
INTRODUCTION

From watches to fitness bands to smartglasses and textiles, wearable electronics are what many believe could be the next big...or small...thing in electronics. Challenging dimensions, product flexibility and demanding functionality requirements have wearables pushing the limits of design and mobile performance integration. Enabling robust functionality, reliability, structural integrity and user-friendly interfaces of wearable devices is highly dependent upon the performance of the electronic materials used to produce today’s wearables and this is where Henkel delivers. With a full portfolio of materials designed to facilitate the demands of wearable electronics, Henkel is helping its customers bring some of the most exciting new products to market.

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ADHESIVES IN ACTION

CONFORMAL COATING

SENSOR ENCAPSULANT

FLEX ATTACH ENCAPSULANT

COMPONENT UNDERFILL

CONDUCTIVE ADHESIVE

CONDUCTIVE INKS

STRUCTURAL ADHESIVES

LOW PRESSURE MOLDING

SOLDER PASTE
Critical to the function of any electrical device are the conductive materials that allow component interconnectivity. Henkel’s line of high-performance solder pastes, electrically conductive adhesives and inks offers the processability, flexibility, product compatibility and low cost of ownership needed for wearable functionality and cost-effective production.

### CONDUCTIVE ADHESIVES

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>DESCRIPTION</th>
<th>CURE</th>
<th>VOLUME RESISTIVITY (Ω·cm)</th>
<th>STORAGE MODULUS at 25°C (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCTITE® ABLESTIK 2030SC</td>
<td>Electrically conductive adhesive with a fast, low-temperature cure designed to minimize stress and resulting warpage between dissimilar surfaces. Good adhesion to inks and metals.</td>
<td>90 sec. at 110°C</td>
<td>0.0002</td>
<td>3,300</td>
</tr>
<tr>
<td>LOCTITE ABLESTIK CA 3556HF</td>
<td>Electrically conductive adhesive with a fast, low-temperature cure, good adhesion and excellent flexibility. Ideal for high throughput production processes and applications where high peel strength is desired.</td>
<td>120 sec. at 110°C</td>
<td>0.0025</td>
<td>650</td>
</tr>
<tr>
<td>LOCTITE ABLESTIK CE 3103WLV</td>
<td>Dispensable, electrically conductive epoxy adhesive with good adhesion to inks and metals.</td>
<td>10 min. at 120°C</td>
<td>0.0008</td>
<td>4,500</td>
</tr>
<tr>
<td>LOCTITE ABLESTIK CE 3104WXL</td>
<td>Printable, electrically conductive epoxy adhesive with good adhesion to inks and metals. Controlled particle sizes provide ultra-fine pitch resolution less than 500 μm.</td>
<td>8 min. at 125°C</td>
<td>0.0007</td>
<td>4,500</td>
</tr>
</tbody>
</table>
## INKS

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>DESCRIPTION</th>
<th>APPLICATIONS</th>
<th>SHEET RESISTANCE (Ω/sq./25 μm)</th>
<th>CHEMISTRY</th>
<th>CONDUCTIVE MEDIUM</th>
</tr>
</thead>
</table>
| **LOCTITE ECI 1006 E&C** | Halogen-free, flexible, conductive, silver-filled, printable ink with fine line and high resolution printing capabilities ideal for tight spaces | • Touch screens  
• Flexible circuits | < 0.030                         | Thermoplastic | Silver         |
| **LOCTITE ECI 1010/1011 E&C** | Flexible, highly conductive, silver-filled, screen-printable ink with lower ink consumption. | • Flexible circuits | < 0.005/0.007                   | Thermoplastic/ Vinlyc | Silver         |
| **LOCTITE ECI 7004LR E&C** | Conductive, screen-printable ink specially designed for blending with LOCTITE NCI 7002 E&C to provide exceptional resistance in the production of low voltage circuitry on polyester film. | • Force-sensitive modules and sensing devices | 35                             | Thermoplastic | Carbon           |
| **LOCTITE ECI 8000 Series E&C** | Positive Temperature Coefficient (PTC), flexible, conductive, screen-printable ink that functions as a self-regulating heater by heating rapidly and maintaining a constant temperature. | • Heating elements  
• Flexible circuits | 1,700                          | Thermoplastic | Carbon           |
| **LOCTITE EDAG PF 455B E&C** | Non-conductive, translucent, flexible, printable ink with excellent humidity resistance and adhesion. Formulated as a crossover dielectric and compatible with other LOCTITE EDAG E&C inks. | • Flexible circuits  
• RFID  
• Biosensors | > 2 × 10^4                     | Acrylate      | N/A               |

## SOLDER PASTES

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>DESCRIPTION</th>
<th>ALLOY</th>
<th>PARTICLE SIZE DISTRIBUTION</th>
<th>IPC J-STD-004B CLASSIFICATION</th>
<th>OPTIMAL SHELF LIFE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LOCTITE GC 10</strong></td>
<td>Halogen- and Pb-free, no-clean, RoHS-compliant solder paste with excellent resistance in high humidity. Industry leader in paste-transfer efficiency. Improved stability at different storage and operating temperatures, with extended stencil life up to 72 hours and extended abandon time up to 24 hours. Suitable for high-density, small to large boards.</td>
<td>SAC305</td>
<td>Type 3, 4, 4.5 (4A), 5</td>
<td>ROLO</td>
<td>12 months up to 26.5°C</td>
</tr>
<tr>
<td><strong>LOCTITE HF 212</strong></td>
<td>Halogen- and Pb-free, no-clean, high tack, low voiding, RoHS-compliant solder paste with excellent fine pitch coalescence. Designed for medium to large boards.</td>
<td>90ISC SAC305 SAC305 SAC387</td>
<td>Type 3, 4, 4.5 (4A), 5</td>
<td>ROLO</td>
<td>6 months at 0 – 10°C</td>
</tr>
<tr>
<td><strong>LOCTITE LM 100</strong></td>
<td>Halogen- and Pb-free, no-clean, solder paste designed for use with low-temperature solder alloys. Formulated to provide excellent dispensability, printability and solderability through various reflow profiles.</td>
<td>Bi58</td>
<td>Type 2</td>
<td>ROLO</td>
<td>6 months at 0 – 10°C</td>
</tr>
</tbody>
</table>
RELIABILITY-ENHANCING MATERIALS

Wearable electronics demand a high degree of reliability and consistent repeatability. They need to survive challenging and varied environments, and maintain performance after being dropped, bent or exposed to water or other fluids. Exceptional moisture, shock, drop and vibration protection is why today’s top wearables manufacturers rely on Henkel. With award-winning underfills, encapsulants, conformal coatings and TECHNOMELT® low pressure molding materials, Henkel provides the reliability wearable devices require for consistent performance and long life cycles.

CONFORMAL COATING

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>DESCRIPTION</th>
<th>BENEFITS</th>
<th>VISCOSITY at 25°C (cP)</th>
<th>CURE METHODS</th>
<th>STORAGE MODULUS at 25°C (MPa)</th>
<th>WVTR* at 50°C/100% RH (mg/m²·day)</th>
</tr>
</thead>
</table>
| LOCTITE® STYCasting PC 40-UMF | Low-viscosity liquid polymer applied by spray or dip allowing for a uniform thin coating. Cured coating protects PCBs from impact of harsh environments such as high humidity, chemical exposure and thermal shock. | - Easily sprayed  
- Fast UV cure  
- Moisture cure for shadowed areas  
- Improved fluorescence for inspection  
- Halogen-free | 250 – 500 | UV and moisture | 1,929 | < 30 |

CONFORMAL COATING
## Encapsulants

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>DESCRIPTION</th>
<th>BENEFITS</th>
<th>CURE</th>
<th>DEPTH OF CURE</th>
<th>VISCOSITY at 25°C (cP)</th>
<th>GLASS TRANSITION TEMPERATURE, ( T_g ) (°C)</th>
<th>STORAGE MODULUS at 25°C (MPa)</th>
</tr>
</thead>
</table>
| Loctite Eccobond EN 3838T | Low \( T_g \) thermal cure encapsulant that provides physical protection for electronic components. | • Reworkable  
• Flexible / low modulus  
• One component  
• Fast cure | > 8 min. at 130°C | N/A | 6,700 | 2 | 550 |
| Loctite Eccobond EN 3860T | CSP/BGA thermal cure encapsulant formulated to have low viscosity and good flow performance. Achieves waterproof capabilities in connector applications. | • Halogen-free  
• Fast cure  
• Good flexibility and high elongation  
• 2x Pb-free reflow without leakage | 10 min. at 130°C or 5 min. at 150°C | N/A | 1,000 | 82 | 1,230 |
| Loctite Eccobond EN 01072 | Thermal cure encapsulant that provides physical protection for connectors and sensitive components in handheld devices. | • High \( T_g \)  
• Low extractable ionics  
• High performance  
• Good shelf life  
• Fast cure | 5 min. at 150°C | N/A | 80,000 | 135 | 6,700 |
| Loctite Eccobond UV 9060F | UV/Moisture-cure encapsulant that provides protection by coating selective components. | • Halogen-free  
• Fast cure  
• One component  
• Cures in shadowed areas | 25 sec. at 500 mW/cm² (365 nm) > 0.25 in. | 11,000 | 75 | 2,200 |

## Low Pressure Molding

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>DESCRIPTION</th>
<th>BENEFITS</th>
<th>COLOR</th>
<th>PERFORMANCE TEMPERATURE</th>
<th>SHORE HARDNESS</th>
</tr>
</thead>
</table>
| Technomelt® PA 6208 Black | Moldable polyamide that provides full encapsulation of electronics and protection from harsh environments. Its fast and easy process requires no mixing and improves throughput. Ideal for encapsulation of heat-producing components in appliances and consumer electronics. | • Good adhesion to PCB surfaces and metal traces  
• Excellent flexibility  
• Provides electrical insulation  
• Low viscosity  
• Excellent moisture and environmental seal | Black | -40°C to 130°C | 78A |

## Underfills

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>DESCRIPTION</th>
<th>BENEFITS</th>
<th>VISCOSITY at 25°C (cP)</th>
<th>POT LIFE at 25°C (days)</th>
<th>GLASS TRANSITION TEMPERATURE, ( T_g ) (°C)</th>
<th>COEFFICIENT OF THERMAL EXPANSION (ppm/°C)</th>
<th>CURE</th>
</tr>
</thead>
</table>
| Loctite E 1216M | Non-reworkable, high-reliability underfill. | • RoHS compliant  
• Under 900 ppm total halogens  
• Excellent thermal cycle performance  
• Excellent drop impact performance | 4,000 | 3 | 125 | 35 | 10 min. at 130°C |
| Loctite Eccobond FP4531 | Underfill for CSP and flip-chip on flex circuits. | • High \( T_g \)  
• Very low CTE  
• Fast cure | 10,000 | 1 | 161 | 28 | 7 min. at 160°C |
| Loctite Eccobond UF 3811 | Flexible, high \( T_g \), reworkable underfill. | • Room-temperature flow capability  
• Halogen-free  
• Good thermal cycling reliability  
• Excellent drop impact performance | 350 | 3 | 124 | 61 | 10 min. at 130°C |
MATERIALS FOR USER INTERFACES

From LCD to LED and the emerging OLED, there are numerous types of displays, or user interfaces, and each has its own unique manufacturing requirements. Not only has Henkel formulated some of the industry’s most promising OLED sealants and FPC reinforcement materials, it has also invested in and partnered with leading developers of next-generation display technologies to help accelerate display advances.

DISPLAY ADHESIVES

<table>
<thead>
<tr>
<th>PRODUCT NAME</th>
<th>DESCRIPTION</th>
<th>CURE</th>
<th>VISCOSITY @ 25°C (cP)</th>
<th>GLASS TRANSITION TEMPERATURE, Tg (°C)</th>
<th>WVTR* (g/m²·day)</th>
<th>PEEL STRENGTH (N/mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FPC Reinforcement Materials</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>LOCTITE® ECCOBOND DS 3318LV</td>
<td>Transparent, one-component, UV-curable acrylic adhesive with high flexibility and good moisture resistance. Suitable for enhancement of flexible printed circuits.</td>
<td>800 mJ/cm² (LED Cure)</td>
<td>968</td>
<td>64</td>
<td>≥ 325.5 (at 25.4 μm thick and 50°C/100% RH)</td>
<td>2.89 (Pi film to FPC-reinforced glass)</td>
</tr>
<tr>
<td><strong>Moisture Barrier Sealants</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOCTITE ECCOBOND DS 7405UV</td>
<td>One-component, acrylate adhesive designed for use as an OLED sealant. Light yellow paste is transparent after UV cure and has low modulus, low warpage and low stress.</td>
<td>≥ 6,000 mJ/cm²</td>
<td>25,000</td>
<td>-38</td>
<td>53 (at 200 μm thick and 60°C/90% RH)</td>
<td>3.4 (glass to glass)</td>
</tr>
<tr>
<td>LOCTITE ECCOBOND DS 8027LV</td>
<td>Translucent, non-conductive, UV-curable epoxy perimeter sealant for OLED displays with good dispensability and excellent permeation resistance to water vapor.</td>
<td>7,500 mJ/cm²</td>
<td>84,000</td>
<td>160</td>
<td>51.15 (at 25.4 μm thick and 50°C/100% RH)</td>
<td>—</td>
</tr>
</tbody>
</table>

* WVTR: Water Vapor Transmission Rate
MATERIALS FOR STRUCTURAL INTEGRITY

Since the infancy of wearables, Henkel has worked closely with the market’s top manufacturers, lending process and design expertise, along with a total solutions approach. In fact, our structural adhesives can be found in multiple wearables applications – and for good reason. The Henkel portfolio of structural adhesives provides manufacturing flexibility with a range of different chemistries to accommodate specific process requirements, addressing numerous applications including bonding of the front cover, magnet, housing, belt to housing and sensor, among others.

STRUCTURAL ADHESIVES

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>DESCRIPTION</th>
<th>OPEN TIME (minutes)</th>
<th>TENSILE STRENGTH (MPa)</th>
<th>TENSILE MODULUS (MPa)</th>
<th>SHEAR STRENGTH ANODIZED Al (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCTITE HHD 3542</td>
<td>One-component polyurethane hot-melt adhesive that provides a strong bond and shock and impact resistance. Very effective on metal, ink-coated glass and engineered plastics.</td>
<td>&lt; 4</td>
<td>≫ 8</td>
<td>91</td>
<td>7.2</td>
</tr>
<tr>
<td>LOCTITE HHD 6305</td>
<td>Halogen-free, two-part polyurethane adhesive with a fast fixture that bonds a wide variety of materials, including most metals, plastics and composites. Exhibits excellent impact and shear strength, moisture resistance and flexibility.</td>
<td>5 – 6</td>
<td>17.83</td>
<td>587</td>
<td>4.6</td>
</tr>
<tr>
<td>LOCTITE HHD 8190R</td>
<td>Two-part acrylic adhesive with a fast cure and excellent moisture resistance. Cured bond has consistent strength over a wide range of temperature and excellent adhesion to multiple substrates, including metals and composites.</td>
<td>3 – 7</td>
<td>23</td>
<td>1150</td>
<td>15</td>
</tr>
</tbody>
</table>