MATERIALS AND SOLUTIONS FOR LED INDUSTRY

Customer Presentation

www.dowcorning.com/electronics
You may know Dow Corning as a global silicone provider.
Serving customers’ diverse needs…

Automotive  
Beauty & Personal Care  
Chemical Manufacturing  
Compound Semiconductor  
Construction  
**Electronics**  
Food & Beverage  
Healthcare  
Household & Cleaning  
Imaging  
Industrial Lubrication  
Paints and Inks  
Power and Utility  
Pressure Sensitive  
Rubber Fabrication  
Textile, Leather & Nonwoven  
Services
Silicones are inorganic compounds with inherently unique properties.

In electronics applications, silicones are especially designed and formulated to function as:

- Durable dielectric insulation
- Stress-relieving and vibration absorbers over a very wide temperature/humidity range
- Barriers against environmental contaminations
- Thermal management materials
Dow Corning Silicone materials for LED Applications
What is LED?

Since their inception in the early ‘60’s, light emitting diodes (LEDs) have gained widespread use and now can be found nearly everywhere.
LED Trends…

Today, special deposition techniques have made possible LEDs with much higher brightness (HB LEDs) than traditional devices. This opens up many new applications such as backlighting for displays, automotive lighting and new consumer products like flash for camera phones or compact projectors.

Goals for these new HB LEDs are to have them
- Be Brighter
- Last Longer
- Cost Less
- Be Compatible with Lead-free Processing
Advanced silicone technology for LED applications

- **LED Protection & Assembly:**
  - Gels
  - Encapsulants
  - Adhesives
  - Conformal Coating

- **LED Thermal Management:**
  - Thermal Interface Materials
    - Wet Dispensed
    - Fabricated

- **LED Packaging:**
  - NRI and HRI Encapsulants
  - HRI Silicone Lens Resin

*We help you invent the future™*
Gel & Elastomers

Their major job is to protect electronic assemblies and components from adverse environments by:
Functioning as dielectric insulation
Protecting the circuit from moisture and other contaminants
Relieving mechanical and thermal stress on components

Silicone elastomer helps protect electronic components and circuits from moisture and contamination; relieves thermal and mechanical stress.

Dow Corning offers a line of standard gels, a line of low-temperature gels for applications requiring low-temperature performance, and a line of specialty gels for applications requiring low extractables, ultra-violet (UV) cure, or resistance to solvents and fuels.

Liquid mixture cures to a flexible elastomer, which is suited for the protection of electrical/electronic assemblies. Select materials have been classified by Underwriters Laboratories.

Standard silicone encapsulants require a surface treatment with a primer while primerless silicone encapsulants require only good cleaning.
Encapsulants: Some Common Applications

Typical applications:
- LED outdoor/indoor panels (Stadium...)
- LED Traffic Lights

Need: to protect the assembly of LED’s and circuit board against humidity and environmental stress

Product:
- Dow Corning® 3-4207 tough gel with Black pigment (selected for its fast cure and adhesion development at room temperature).
- Dow Corning® SE 1816 CV or Dow Corning® SE 1817 CV (selected because of self-priming capability)
- Dow Corning® EE-1840 (selected because of black color and room temperature cure)
Adhesives & Sealants

Dow Corning offers a variety of noncorrosive silicone products for electronic sealing, bonding and adhering applications. These adhesives generally fall into three cure types.

2. Condensation cure: Offers rapid room-temperature and deep-section curing.
3. Heat cure: For rapid processing. All convert to durable, relatively low stress elastomers. Most will develop good, primerless adhesion to a variety of common substrates including ceramics, reactive metals and filled plastics.

Adhesive: Substance capable of holding materials together by surface attachment

Sealant: Material applied to a joint or gap to form a seal against gas or liquid entry

Sealing, Bonding, and Adhering

Noncorrosive silicone products for electronic sealing, bonding and adhering applications.

- Resistant to weathering
- Stable at high temperatures
- Flexible at low temperatures
- Excellent electrical properties
Adhesives & Sealants: Some common applications

Case: Large outdoor video display panels used in stadiums, exhibitions etc... High intensity LED’s (Blue, green and red) are used as base pixels for live video displays.

Need: Assembly of PCB into plastic frame

Product: Dow Corning® 744 adhesive/sealant (excellent adhesion on plastics)

Typical applications:
- Architectural lighting
- Automobile interior and exterior lighting
- Indicators, switchers, keypads
- LCD backlighting
- Displays
- Mobile device light sources
- Projector light sources
- Traffic lights and guidance
Thermally Conductive Materials

When markets demand smaller, faster, less expensive electronic devices and assemblies, you respond. But smaller components, tighter lead spacing and increased operating frequencies result in higher temperatures that can reduce performance and reliability. Heat is the enemy of performance. To win over this enemy Dow Corning can offer you:

**Thermal Interface Materials - Wet Dispensed**

**Thermal Interface Materials - Fabricated**

Functions of Thermally Conductive materials:

- Carry heat transfer **AWAY** from components to the environment
- (Electrical insulation) between components and casing
- Flexible fixation
Thermally Conductive Materials – Wet Dispensed

Dispensable, printable and curable materials effective as heat transfer media

**Adhesives**
- One or two-part silicone elastomer
- Nonflowable and flowable options; cures to flexible elastomer
- Fast thermal cure, or RTV cure available; resists humidity and other harsh environments; good dielectric properties; self-priming adhesion; low stress; noncorrosive

**Encapsulants**
- Two-part silicone elastomer
- Flowable liquid; cures to flexible elastomer
- Constant cure rate, regardless of sectional thickness or degree of confinement; no post-cure required

**Gels**
- Two-part silicone gel
- Low to moderate viscosity; cures to gel like material
- Long working times, fast thermal cure; resists humidity and other harsh environments; good dielectric properties; self-priming adhesion; low stress; non-corrosive

**Compounds**
- Non-curing, thermally conductive silicone paste.
- High thermal conductivity; low bleed; high-temperature stability
Dow Corning offers Thin Thermal Interface materials and Gap Filler Thermal Interface materials for use on irregular surfaces.

Cold applied pre-cured, easy to die cut, highly compressible from both sides to improve thermal resistance.
Thermally Conductive Materials: Some Common Applications

Case: Day running lights (Automotive)
Need: Transfer heat from a flexboard carrying power LEDs to series of individual heatsinks
Product: Dow Corning® SE4486 RTV adhesive

Case: Arcade machines
Need: Transfer heat from a band of low power LEDs to the heatsink for arcade machines
Product: Dow Corning® TP-1500 Thermal Pads
Why use Dow Corning Silicones for LED packaging?

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
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<tbody>
<tr>
<td>Excellent thermal stability (as low as -45 to &gt;260°C)</td>
<td>Enables packages to pass common industry reliability and lead-free reflow temperatures</td>
</tr>
<tr>
<td>Very low moisture uptake</td>
<td>Packages can be designed to conform to industry reliability standards</td>
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<td>Variable modulus (typically less than 1 MPa)</td>
<td>Design flexibility to absorb stress within the package</td>
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<td>Excellent adhesion to a wide variety of materials</td>
<td>Improved device reliability because of delamination resistance</td>
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<td>Low ionic content (typically ionic levels &lt;1 ppm)</td>
<td>Minimized corrosion potential</td>
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<tr>
<td>Excellent optical properties (high light transmittance)</td>
<td>Well-suited for near IR, visible, or UV wavelength applications</td>
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<td>Dispensed or molded by a variety of techniques</td>
<td>Efficient automated assembly process</td>
</tr>
<tr>
<td>Wide range of viscosities available</td>
<td>Reliable dispense and molding processes</td>
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Optical Silicone Characteristics

- UV-vis transmittance (350-900 nm) Excellent
- IR transmittance (1300 & 1600 nm) Good
- Birefringence < 2x10^-4
- Refractive index tailored to 1.42 to 1.54
- Thermo-optic coefficient (dn/dT) ~ -4x10^-4 /K
- Coefficient of Thermal Expansion ~ 200 ppm/°C
- Flexural Modulus 150-450 MPa
Optical Encapsulants

Encapsulants: Gel, Elastomer and Resin

Dow Corning provides both High RI and Normal RI OE series silicone encapsulants, which have outstanding light transmittance across the application wavelengths of LEDs.

These encapsulants provide excellent stress relief, moisture protection and UV resistance for LED chip sealing and protection.

• Physical Form: Low to medium viscosity liquid; cures to a flexible gel or elastomer.
• Special Properties: Transparent with refractive index range of 1.41 to 1.53.
• Potential Use: Protection of LED devices.
Finding your way between High RI and Normal RI

<table>
<thead>
<tr>
<th></th>
<th>Gel</th>
<th>Soft Elastomer</th>
<th>Hard Elastomer</th>
<th>Resin</th>
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<tbody>
<tr>
<td></td>
<td>Shore A&lt;10</td>
<td>Shore A&lt;50</td>
<td>Shore A&gt;50</td>
<td>Shore D&gt;30</td>
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<tr>
<td>Normal RI</td>
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<td>Dow Corning® JCR 6122</td>
<td>Dow Corning® EG-6301</td>
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<td>RI&lt;=1.42</td>
<td>Dow Corning® OE-6250</td>
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<td>Dow Corning® OE-6336</td>
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<td></td>
<td>Hipec® Q1-4939</td>
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<tr>
<td>High RI</td>
<td>Dow Corning® OE-6450</td>
<td>Dow Corning® OE-6520</td>
<td>Dow Corning® OE-6550</td>
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<tr>
<td>RI&gt;1.50</td>
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<td>Dow Corning® OE-6630</td>
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<td>Dow Corning® OE-6635</td>
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</table>
Why use Silicone Encapsulants with LED?

**Transmittance (after cure)**
- High transparency between 350 nm to 800 nm
- Higher transparency between 300 nm to 400 nm than epoxy

**Transmittance (after UV irradiation)**

Higher UV stability than epoxy

Sample thickness = 4 mm
Epoxy = typical optical grade epoxy

Test condition: UV = 365 nm, 19m W/cm², 4h
Why use Silicone Encapsulants with LED?

**Storage Modulus**
Hard material becomes softer at high temperature, therefore, stress in package can be minimized.

**Transmittance (after thermal aging)**
- Less than 5% decrease at 150°C for 1,000h

Thickness = 1 mm, Transmittance = 400 nm
Sample aging condition = 150°C, Air
Lens Molding

Lens Molding: Elastomer and Resin
Dow Corning provides the high RI resin material needed for optical lens fabrication. These products are designed with excellent injection and compress molding characteristics.

Features:
- Shore D Range Hardness
- High optical transparency
- Excellent UV, temperature and moisture stability

Applications:
- Discrete Lenses for LEDs
- On-chip molded lenses (overmolding)
- Light guides, light pipes
Lens Molding: Methods

Cavity Molding (Casting)
  Low cost of ownership, Low material loss

Compression Molding (Overmolding)
  Low running cost – Substrate level process
  Material options: high RI OE-66XX resins series

Injection molding
  High productivity, complex shape manufacture
Examples of Molded Parts
Dow Corning Unique Selling Proposal for LED market

Dow Corning is the answer to your LEDs needs from high performance optical materials, potting and thermal management solutions to a highly integrated molding equipment and application process capability complemented with the global research and development experts.
THANK YOU!

Dow Corning

Lighting the way to advanced materials and solutions

Global Network
LED Solutions is a globally integrated provider of materials, applications technology and equipment integration services.

Excellent Silicone Materials Properties
Our materials provide thermal and optical stability with properties that improve device reliability, and are resistant to yellowing in blue wavelength and high-flux white light.

Benefits Provider
Optical-grade silicones gels and elastomers provide stress relief, improved light extraction, mechanical protection and lead-free solder processability. Resins are moldable into optical parts to direct and enhance light output.

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