



Boost Your PCB Module Reliability

with DOWSIL™ Gels, Encapsulants,
and Conformal Coatings



UL Prospector Webinar, October 24, 2018
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Technical Service & Development, The Dow Chemical Company

Agenda

- Why Do PCB and Components Need Protection?
- How Do Protection Materials Work?
- Why Silicones for Protection Applications?
- Choosing Your Silicone Protection Solution
- Range of Protection Solutions
 - Coatings
 - Gels
 - Encapsulants
 - Specialized Solutions
- Questions



Why Do PCB and Components Need Protection?

- **Electrical Failure**

- Corrosion
- Thermal stresses (CTE mismatch)
- Vibration
- Mechanical shock/impact
- Harsh environments
(e.g. debris, fluid/chemical exposure)

- **Overheating**

- **Competition**



Imagine

How Do Protection Materials Work?

New Solutions.
New Brand Name.

DOWSIL™
silicones by 

- **Electrical Insulation**
- **Complete Coverage and Sealing of Components**
 - Wet-out
 - Adhesion
 - Durability (heat, cold, water/moisture, chemicals)
- **Mechanical Stress Reduction**
 - Vibration
 - Shock
- **Thermal Stress Reduction**
 - Coefficient of Thermal Expansion (CTE)
 - Overheating



Why Silicones For Protection Applications?



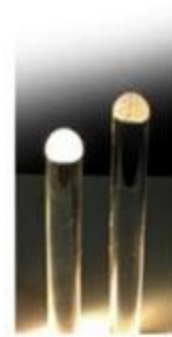
ORGANIC

- Easier to process
- Range of properties
- Less thermally stable



Silicone

Silicones have properties that combine glass and organic polymers



INORGANIC

- Thermally stable
- Optically clear
- Complex to process

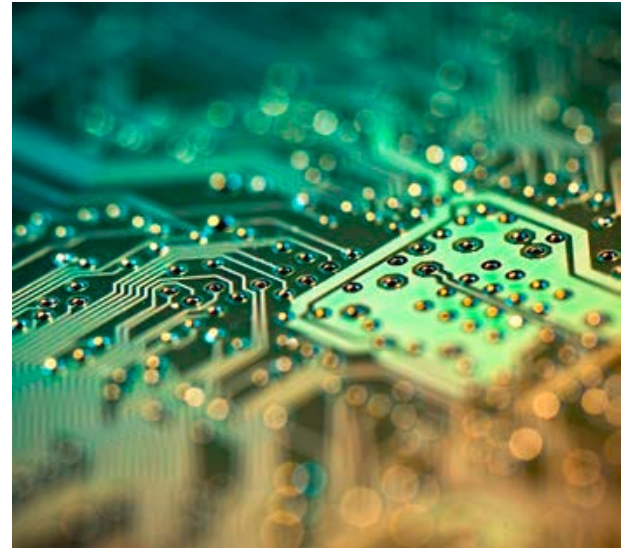


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Why Silicones For Protection Applications?

As a Class of Materials, Silicones Generally Offer Demonstrable Benefits over Acrylic, Urethane, and Epoxy Solutions

- **Maximum protection** – especially from silicone gels
 - **against mechanical stress** caused by thermal cycling or mismatched coefficient of thermal expansion
- **Extraordinary protection against shock and vibration**
- **Superior thermal stability** - more reliable performance at sustained temperatures between -45°C and 200°C
- **Greater hydro-stability** and **stronger resistance** to chemicals and UV radiation

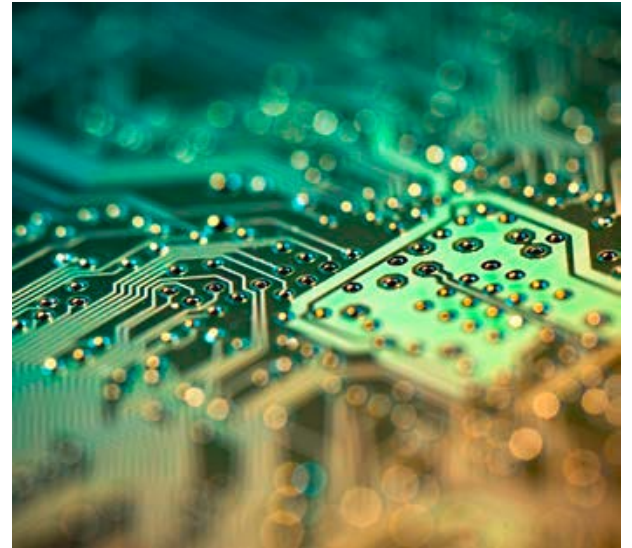


Imagine

Why Silicones For Protection Applications?

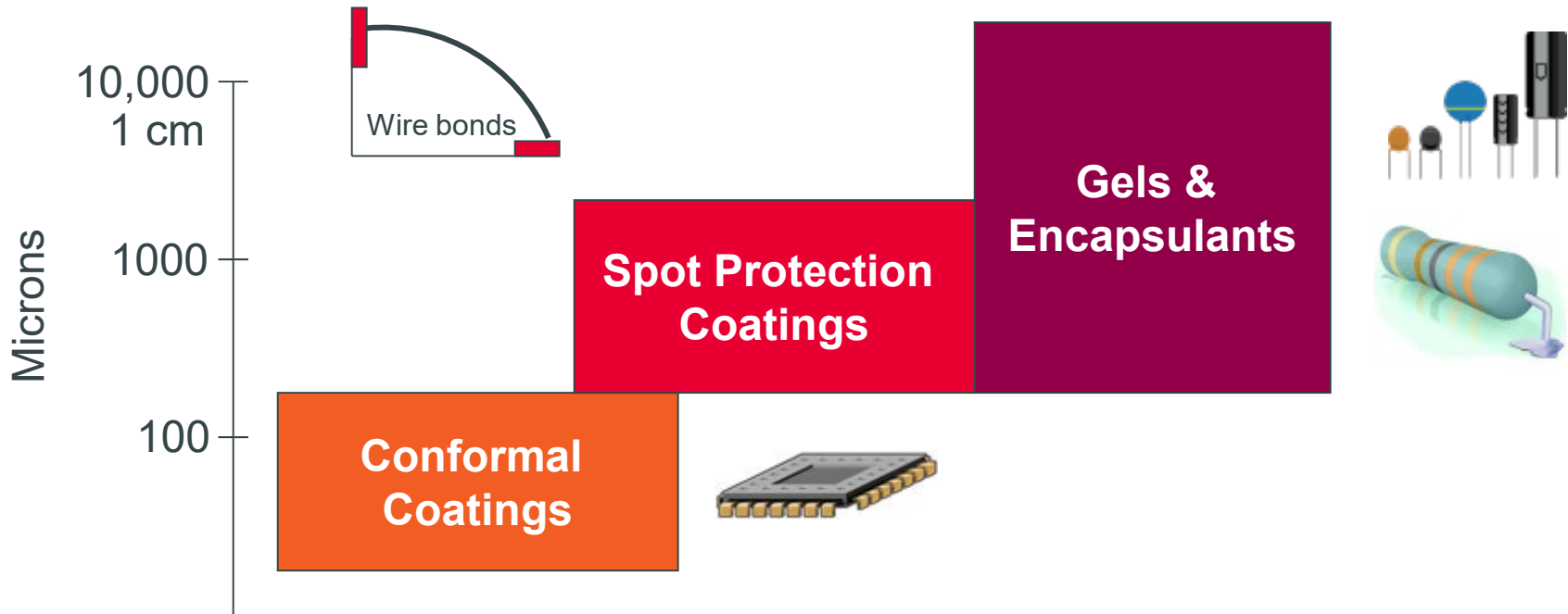
As a Class of Materials, Silicones Generally Offer Demonstrable Benefits over Acrylic, Urethane, and Epoxy Solutions

- **None of the toxicity issues of organics**, helping to reduce or eliminate special handling precautions
- **Temperature-accelerated cure** of silicones **imposes** a significantly **lower impact** on end properties
- **Simpler processing** without the need for oven drying or concerns about exotherms
- **Ease of repair** when module rework is necessary
- **A wide range of special features**, targeting multiple functions like thermal management, improved processing efficiency, and others



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Choosing Your Silicone Protection Solution



Range of Protection Solutions

- **Coatings**
- **Gels**
- **Encapsulants**
- **Specialized Solutions**



Range of Protection Solutions

Coatings

- Various viscosities
- Thin layer
- Stress relief
- Abrasion resistant



Coatings

| Benefits | Limitations |
|--|-----------------------|
| Greater thermal stability - temperature range from -45°C to 150°C | Thin layer (<1 mm) |
| Improved stress relief with broad range of elastomeric coatings | Simple / flat designs |
| Improved mechanical resistance with elastoplastic coatings | |
| Fast, heat or room-temperature cure | |
| Low viscosity for high-speed production to higher viscosity for better thickness control | |
| Meeting UL 94, UL 746E and IPC-CC-830A | |



DOWSIL™ Elastomeric Coatings Portfolio

Stress Relief

| Product | Viscosity (cP) | Hardness (Shore A) | Tack-Free Time (min) |
|--|----------------|--------------------|-----------------------------|
| DOWSIL™ 1-4105 Conformal Coating | 450 | 65 Shore 00 | Heat cure 10 min @ 105°C |
| DOWSIL™ CC-4555 Long Bath Life Conformal Coating | 225 | 78 Shore 00 | Heat cure 20 min @ 120°C |
| DOWSIL™ SE 9187 L Adhesive | 1,100 | 17 | 8 |
| DOWSIL™ SE 9186 L Sealant | 27,000 | 25 | 8 |
| DOWSIL™ 3-1965 Conformal Coating | 115 | 33 | 6 |
| DOWSIL™ 3140 RTV Coating | 34,400 | 32 | 116 |
| DOWSIL™ 3-1944 RTV Coating | 64,000 | 36 | 14 |



silicones by 

Range of Protection Solutions

Gels

- Very flowable
- Soft
- Highly stress relieving
- Tacky
- Self-healing



Gels

| Benefits | Limitations |
|--|--|
| Highly stress relieving due to softness <ul style="list-style-type: none">• Maximum protection against mechanical stress caused by thermal cycling or mismatched coefficient of thermal expansion | Weak protection against mechanical impact due to softness |
| Self-healing when torn or cut | High coefficient of thermal expansion |
| Easily repairable | |
| Good surface wetting due to very low viscosities | |
| Tackiness provides physical adhesion to common surfaces without the need for primers | |



Gels - DOWSIL™ Standard Gels Portfolio



Stress Relief

| Product | Viscosity (mPa.s) | Gel Hardness (g) | Room-Temperature Cure |
|--|-------------------|------------------|-----------------------|
| DOWSIL™ 3-4118 Gel | 7,000 | 50 | Possible |
| DOWSIL™ 3-4170 Dielectric Gel | 465 | 78 | Heat Cure |
| DOWSIL™ 3-4680 Silicone Gel | 260 | 88 | 30 min |
| DOWSIL™ 3-4154 Dielectric Gel | 550 | 100 | Heat Cure |
| DOWSIL™ 3-4150 Dielectric Gel | 475 | 110 | 90 min |
| SYLGARD™ 527 Silicone Dielectric Gel | 465 | 113 | > 1 week |
| DOWSIL™ 3-6636 Silicone Dielectric Gel | 3,300 | 125 | 24 hrs |



Imagine

Gels - DOWSIL™ EG-3810 Gel

Key Features

- Excellent thermal stability from -60°C to 200°C
- Reliable protection against damaging environmental conditions
- Superior buffer against mechanical stress
- Reliable dielectric insulation
- Cures quickly



| Property | DOWSIL™ EG-3810 Gel |
|---------------------|--------------------------|
| Color | Clear |
| Viscosity | 690 mPa.s |
| Heat Cure Only | 15 @ 125°C 10 @ 150°C |
| Gel Hardness | 78 g |
| Dielectric Strength | 21 kV/mm |

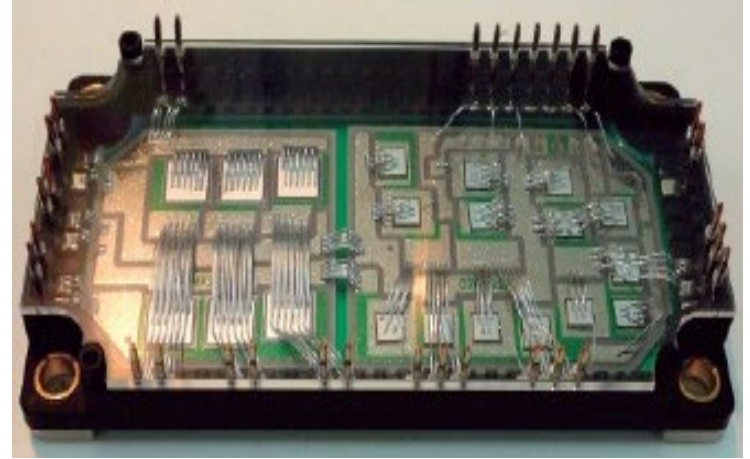
Gels - DOWSIL™ EG-3810 Gel

Benefits

- Long-lasting, reliable device performance in extreme conditions
- Protects delicate leads against thermal cycling, impact, and vibration
- Improved productivity

Typical Applications

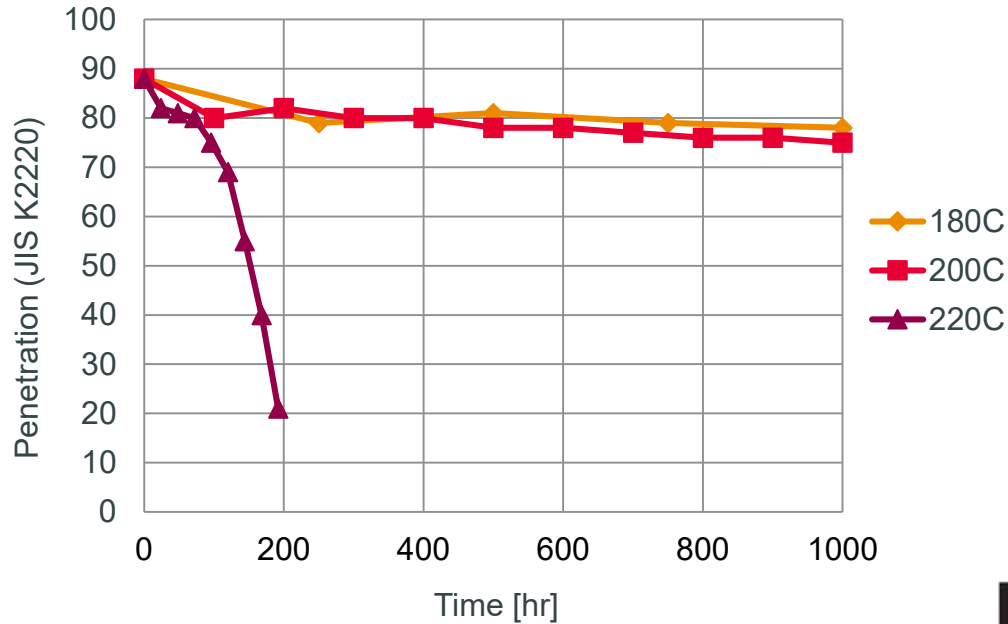
- Power conversion, such as IGBT modules
- Automotive under-the-hood PCB system assemblies
- Industrial sensors and actuators



Imagine

Gels - DOWSIL™ EG-3810 Gel

Penetration Change by High-Temperature Aging



Gels - Dow Tough Gels Portfolio

Stress Relief

| Product | Viscosity (mPa.s) | Hardness (Shore 00) | Room-Temperature Cure |
|-------------------------------------|-------------------|-----------------------|-----------------------|
| SYLGARD™ 528 Firm Gel | 400 | Gel Hardness 200 g | Possible |
| DOWSIL™ EG-3896 | 520 | Gel Hardness 220 g | Heat Cure |
| DOWSIL™ 3-4133 Dielectric Gel | 450 | Gel Hardness 600 g | Possible |
| DOWSIL™ 3-4222 Dielectric Firm Gel | 340 | 34 | 30 min |
| DOWSIL™ 3-6512 Elastomer | 925 | 40 | Possible |
| DOWSIL™ 3-4207 Dielectric Tough Gel | 415 | 61 | 90 min |
| DOWSIL™ 3-4241 Dielectric Tough Gel | 410 | 61 | 11 hrs |



Imagine

Range of Protection Solutions

Encapsulants

- Flowable
- Mechanical protection
- Primerless available
- Thermal management



Encapsulants

| Benefits | Limitations |
|---|---------------------|
| Greater resistance to abrasion and damage | Lower stress relief |
| Easily repairable | Higher hardness |
| Wide range of viscosities | |
| Primerless adhesion available | |
| Optional thermal conductivity | |
| Meets UL 94 | |



Dow Standard Encapsulants



| Product | Viscosity (mPa.s) | Hardness (Shore A) | Working Time (hours) |
|--|-------------------|--------------------|----------------------|
| SYLGARD™ 186 Silicone Elastomer | 65,000 | 24 | 1.65 |
| DOWSIL™ 3-6121 Low Temperature Elastomer | 19,000 | 34 | >2 |
| SYLGARD™ 182 Silicone Elastomer | 5,700 | 52 | 8 |
| SYLGARD™ 160 Silicone Elastomer | 4,865 | 56 | .30 |
| SYLGARD™ 184 Silicone Elastomer | 3,500 | 43 | 1.5 |
| SYLGARD™ 170 Silicone Elastomer | 2,350 | 47 | .25 |
| DOWSIL™ EE-3200 Low Stress Encapsulant | 1,700 | 20 Shore 00 | .50 |
| DOWSIL™ 3-6512 Elastomer | 925 | 40 Shore 00 | 24 |



Imagine

Dow Thermally Conductive Encapsulants



| Product | Viscosity (mPa.s) | Hardness (Shore A) | TC (W/m.K) |
|--|-------------------|--------------------|------------|
| DOWSIL™ TC-6020 Thermally Conductive Encapsulant | 10,600 | 63 | 2.72 |
| DOWSIL™ TC-4605 Thermally Conductive Encapsulant | 2,900 | 35 | 1.00 |
| SYLGARD™ Q3-3600 Thermally Conductive Encapsulant | 3,100 | 86 | 0.8 |
| DOWSIL™ CN-8760 G Thermally Conductive Encapsulant | 3,200 | 45 | 0.67 |
| SYLGARD™ 160 Silicone Elastomer | 7,500 | 56 | 0.6 |
| DOWSIL™ EE-3200 Low Stress Encapsulant | 1,700 | 20 Shore 00 | 0.5 |



Imagine

UL Prospector Webinar - Thermal Management



[Watch the recorded webinar](#) and learn more about thermal management.



Dow Primerless Encapsulants



| Product | Viscosity (mPa.s) | Hardness (Shore A) | Working Time (hours) |
|--|-------------------|--------------------|----------------------|
| DOWSIL™ 3-8264 Encapsulant | 2,700 | 44 | 5 |
| SYLGARD™ 567 Primerless Silicone Encapsulant | 1,300 | 40 | >3 days |
| DOWSIL™ SE 1816 CV Encapsulant | 2,600 | 35 | >24 |
| DOWSIL™ EE-1840 Encapsulant | 1,350 | 21 | 0.2 |
| DOWSIL™ EE-3200 Low Stress Encapsulant | 1,700 | 20 Shore 00 | 0.5 |

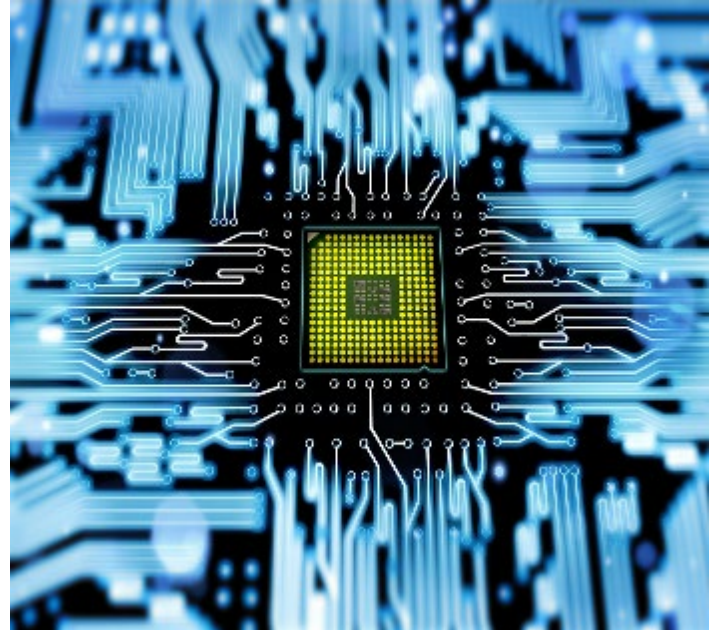


Imagine

Range of Protection Solutions

Specialized Solutions

- Space Grade
- Transportation (EN 455545-2)
- Optical
- Solvent and Fuel Resistance
- UV Curing



Specialized Protection Solutions

Space Grade: DOWSIL™ 93-500 Space Grade Encapsulant

- Low levels of volatiles, proven for space-grade applications (ASTM E595)

Resistance: DOWSIL™ Q3-6679 Dielectric Gel


- Fluoro-based with enhanced resistance against solvents and fuels

UV Curable: DOWSIL™ X3-6211 Encapsulant

- A UV curable gel with a long working time - protection with low-temperature applications



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Specialized Protection Solutions

Optical: DOWSIL™ EI-1184 Optical Encapsulant

- Very high transparency and good reliability for optical applications

Transportation:

DOWSIL™ EE-3200 Low Stress Silicone Encapsulant, SYLGARD™ 170 Silicone Elastomer

- Meet EN 45545-2 fire protection standard requirements R22 to R26



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