

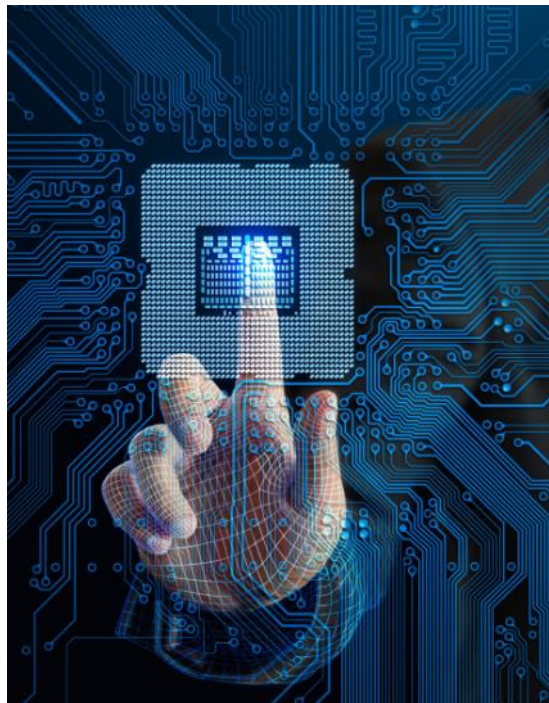


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Silicones from Dow for Appliances

Featured DOWSIL™ and
SYLGARD™ brand Solutions

consumer.dow.com/pcb



DOWSIL™

silicones by 

Benefits of Silicones from Dow

- Extensive product line
- Proven application performance
- Leading global technical service
- A commitment to quality
- Fully global supply capability
- Continuing innovation



Imagine

Silicone Adhesives and Sealants

- Benefits of DOWSIL™ silicone adhesives and sealants
- Application examples

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Benefits of DOWSIL™ Silicone Adhesives and Sealants

Wide Temperature Range

- Many products can be used from -65°C to 232°C (when fully cured)

Extremely Weather-Resistant

- Virtually unaffected by weather – including rain, sleet, snow, ultraviolet (UV) radiation, ozone and temperature extremes

Good Dielectric Properties

- Good dielectric properties over wide thermal-cycling conditions

Good Bond Strength

- Specially designed to provide good adhesion and bond strength to a variety of surfaces



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Benefits of DOWSIL™ Silicone Adhesives and Sealants

(continued)

Low Flammability

- In fire conditions, DOWSIL™ silicone adhesives and sealants are reluctant to burn; in fact, some grades are exceptionally flame-retardant

Good Chemical Stability

- Ideal for use in applications exposed to harsh environments

Environment

- Dow is always striving to improve operations, working largely from the framework of the *Responsible Care*® Pollution Prevention Code



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Application Example: Stovetop Sealing

Application Needs

- Sealing frame to kitchen counter
- Sealing/bonding glass (adhesive seal)

Material Requirements

- Heat resistance
- Hot water resistance
- Good adhesion
- Good tooling

Potential Product Solutions

- Adhesive seal: DOWSIL™ 732 Multi-Purpose Sealant
- DOWSIL™ EA-2626 Adhesive
- SILASTIC™ Q3-3636 Adhesive
- DOWSIL™ Q3-1566 Heat Resistant Adhesive/Sealant
- Silicone Foams

Target Customers

- Ceramic hob manufacturers



Sealing/bonding
glass plate to frame

Sealing frame to
kitchen counter

Application Example: Supermarket Display

Application Needs

- Gap filling/bonding

Material Requirements

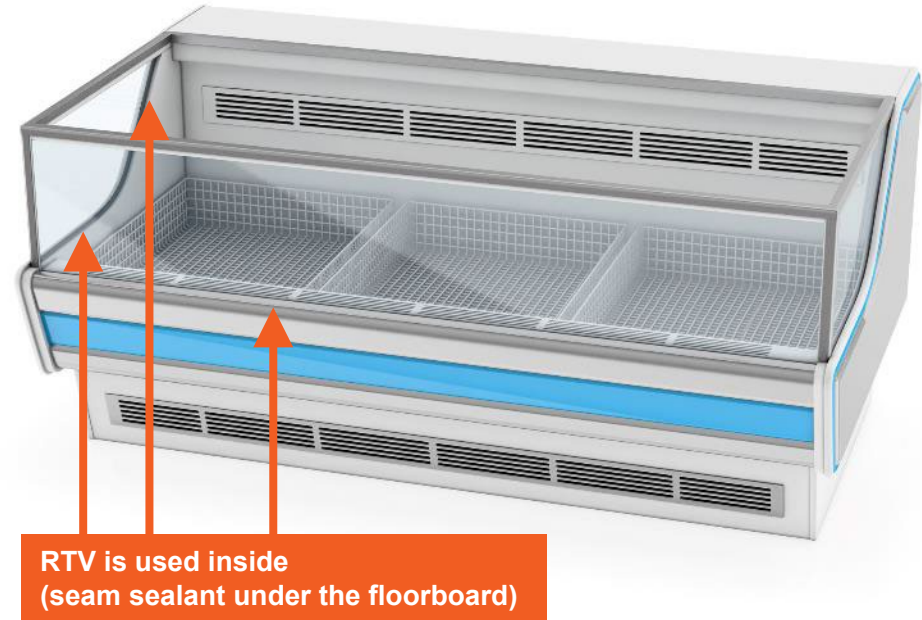
- Good adhesion to various metals, plastics and glass
- Water resistance
- Flexible bond at low temperatures

Potential Product Solutions

- DOWSIL™ 732 Multi-Purpose Sealant
- DOWSIL™ 737 Neutral Cure Sealant
- DOWSIL™ 7091 Adhesive Sealant
- DOWSIL™ AS 7096N Sealant
- DOWSIL™ HM-2600 Silicone Assembly Sealant

Target Customers

- Industrial freezer display case manufacturers



Application Example: Commercial Kitchen Equipment

Application Needs

- Adhesive seal
- Gap filling/bonding

Material Requirements

- Good adhesion to various metals, plastics and glass
- Heat resistance
- Fluid resistance (hot water, detergent)

Potential Product Solutions

- DOWSIL™ 732 Multi-Purpose Sealant
- DOWSIL™ 736 Heat Resistant Sealant
- DOWSIL™ 733 Glass & Metal Sealant
- DOWSIL™ Q3-1566 Heat Resistant Adhesive/Sealant
- DOWSIL™ 7091 Adhesive Sealant

Target Customers

- Kitchen equipment manufacturers



Commercial kitchen equipment



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Application Example: Oven Door, Microwave Door

Application Needs

- Bonding outer window to frame
- Bonding inner window to frame

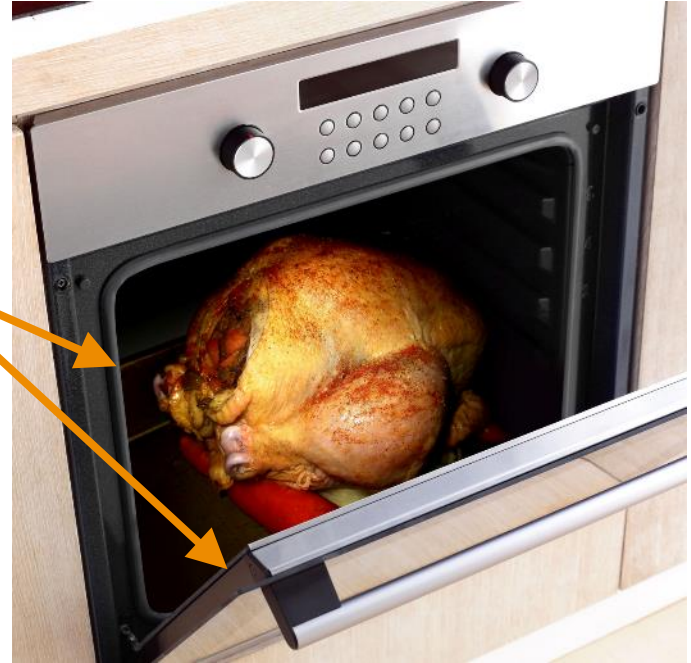
Material Requirements

- Heat resistance (up to 250°C)
- Good adhesion to glass
- Good adhesion to painted metal

Potential Product Solutions

- DOWSIL™ 3-6096 Adhesive
- DOWSIL™ Q3-3526 Sealant
- DOWSIL™ 736 Heat Resistant Sealant
- DOWSIL™ 732 Multi-Purpose Sealant
- DOWSIL™ EA-2626 Adhesive
- SILASTIC™ Q3-3636 Adhesive

Oven door seal



Application Example: Refrigerator

Application Needs

- Seam sealant for plastic/plastic or plastic/metal
- Bonding silicone rubber gasket to cover

Material Requirements

- Good adhesion to plastic and metal
- Good adhesion to silicone rubber
- Good adhesion/flexible bond at low temperatures

Potential Product Solutions

- DOWSIL™ 732 Multi-Purpose Sealant
- DOWSIL™ 737 Neutral Cure Sealant
- DOWSIL™ 748 Non-Corrosive Sealant
- DOWSIL™ 750 Plastic Surface Adhesive/Sealant
- DOWSIL™ 7091 Adhesive Sealant
- DOWSIL™ AS 7096N Sealant

Target Customers

- Refrigerator manufacturers



Seam sealant



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Application Example: Washing Machine Cover

Application Needs

- Sealing and bonding
- Enhanced productivity

Material Requirements

- Good adhesion, developed quickly
- High green strength
- Clarity

Potential Product Solutions

- DOWSIL™ HM-2500 Assembly Sealant
- DOWSIL™ HM-2600 Silicone Assembly Sealant
- DOWSIL™ 7091 Adhesive Sealant
- DOWSIL™ EA-2626 Adhesive

Target Customers

- White-good manufacturers



Silicone Hot-Melt Adhesives

- Benefits of DOWSIL™ hot-melt adhesives
- Available products for Industrial Assembly & Maintenance
- Product properties

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Benefits of DOWSIL™ Silicone Hot-Melt Adhesives

- True family with members
 - Multipurpose with FDA & NSF
 - High-temperature stability
 - Flowable, self-leveling behavior
- Durable adhesion to most substrates without primer
- Enable productivity with fast green strength
 - Can ship parts quickly
- Clear



Typical Properties of Silicone Hot-Melt Adhesives

Product Property	DOWSIL™ HM-2500 Assembly Sealant	DOWSIL™ HM-2510 Assembly Sealant	DOWSIL™ HM-2515 Assembly Sealant	DOWSIL™ HM-2520 Assembly Sealant	DOWSIL™ HM-2600 Silicone Assembly Sealant
Specific gravity	1.08	1.08	1.07	1.11	1.08
Viscosity at 120°C, Pa·s	200	110	27	110	70
15-min green strength, MPa	0.06	0.04	0.004	0.03	0.03
Durometer, Shore A	49	38	14	31	60
Ultimate tensile strength, MPa	3.5	4.6	2.3	6.0	4.4
Ultimate elongation, %	1,900	1,900	1,500	1,500	1,300
Tear strength – Type B, pli	80	78	67	89	70
Peel strength ¹ , pli	> 45	> 41	> 33	> 30	> 30
SAFT ² , °C	250	250	248	280	>300
NSF/ANSI Standard 51 and 61 ³	✓	✓	✓	✓	✓
FDA 21 CFR 177.2600 ³	✓	✓		✓	✓
UL 94 (Relative Thermal Index)	HB (105) ^{3,4}	HB (105) ^{3,4}	HB (105) ⁴	N/A	HB (105) ⁴
Color	Clear	Clear	Clear	Clear	Clear

Specification writers: These values are not intended for use in preparing specifications. Please contact your local Dow representative or sales office before writing specifications on these products.

¹180° peel from various substrates based on ASTM C794: 21-day cure + 7-day H₂O immersion.

²Shear Adhesion Failure Temperature based on ASTM 4498 but with a 0.10-in bondline.

³Industrial, Appliance and Maintenance.

⁴PCB and Systems Assembly.



Imagine

Silicone Conformal Coatings

- Overview
- Industry trends
- Benefits of DOWSIL™ silicone conformal coatings
- Cure profile options
- Product selection tree

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Overview: Conformal Coatings

Description and Use

- **Thin protective films/breathing membranes** that filter water vapor and solid debris
- Provide **environmental and mechanical protection** of circuitry and components
- Used in thicknesses of **25 to 200 μm**

Key Benefits of DOWSIL™ Conformal Coatings

- Improve **reliability** in humid environments
- Protect PCBs and other system components against **environmental particles, moisture and contaminants**, preventing **short circuits and corrosion** of conductors and solder joints
- Protect circuits and components from **abrasion and solvents**
- **Stress-relieving**
- Protect **insulation resistance**
- Reduce **conductor spacing** on PCBs
- Offer good **dielectric properties** (insulation, moisture resistance, breakdown voltage)



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Industry Trends for Conformal Coatings

General market trends and implications for conformal coatings

- System integrated
- Increasing capacitance
- Smaller
- Higher speed
- Modular
- Eco-friendly
- Low power consumption
- Smaller PCBs and components vs. higher power and efficiency
 - Use of components in very harsh environments
 - Higher need for protecting circuits

Material needs for conformal coatings

- For harsher environments:
 - Excellent **protection** in highly **humid** and **corrosive** environments
 - Excellent flame **retardancy** and **electrical** properties
- Regulations
 - Less VOC
 - Solventless
 - UV cure
 - Water-based and moisture cure coatings (100% solid silicones)

Why Use Silicones?

	Acrylic	PU	Epoxy	Silicone
Thermal Stability	--	-	--	++
Moisture Resistance	-	-	--	++
Solvent Resistance	-	+	++	0
Adhesion	+	+	++	+
Repairable	++	--	0	+

-- Very low - Low 0 Medium + High ++ Very high

Cure Profile Options for Conformal Coatings

Fast moisture-cure

- Quick room-temperature cure
- A “dispense-and-forget” solution; tack-free and ready for production in <10 minutes
- Ideal option for high-volume assembly operations

Extended-working-time moisture-cure

- Extended room-temperature cure to allow the material to flow farther over large or complex boards
- Preferred solution for applications that require a thicker coating

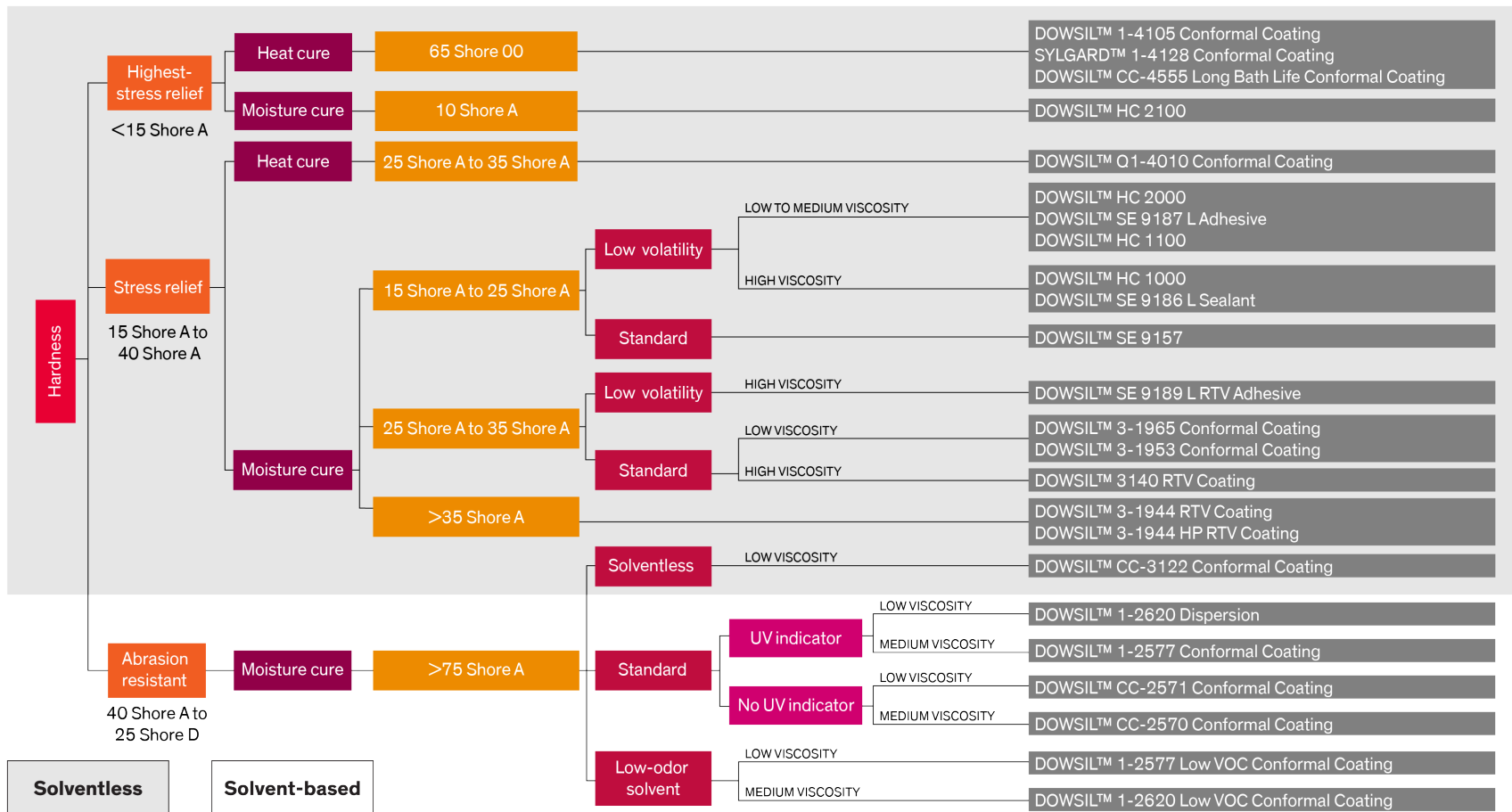
Heat cure

- “Command cure” materials provide control of cure rate
- Material of choice when processing operations demand full cure in <5 minutes
- May impose lower stress on board components during thermal cycling



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Conformal Coatings Product Selection Tree



Silicone Thermally Conductive Materials

- Industry trends
- Adhesives
- Compounds
- Elastomer & gels
- Product summary

Imagine

Industry Trends for Thermally Conductive Materials

Improved thermal management is increasingly critical to maintaining long-term performance and reliability of PCB module assembly in virtually every industry.

General Trends

- High-functionality/high-performance appliances require higher power density, leading to increasing temperatures
- Improved thermal management is required to dissipate heat in these devices for improved performance, reliability and lifetime
- Improved thermal management also improves design flexibility
- Form factor optimization is a key challenge – “thin is in”
- Increasing demand for higher performance and more cost-effective thermal management solutions



Overview: Thermally Conductive Adhesives

Description

- High-performance materials range from low-viscosity liquids to nonslump formulations
- No significant by-products during processing, allowing use as structural adhesives without mechanical fasteners, even in complete confinement

Product Types

- One-part moisture-cure grades offer simple room-temperature processing to minimize costs
- One- or two-part heat-cure solutions help accelerate processing to speed time to market

Benefits

- Strong bonds that dissipate heat
- Expanded design and process flexibility
- Enhanced design flexibility by filling oddly-shaped gaps and generating large contact areas to maximize heat transfer
- Ease manufacturing challenges when part planarity and fit tolerances cannot be tightly controlled
- Surface contact helps reduce interfacial resistance
- After cure: Adhesive becomes a strong yet flexible elastomer; delivers good unprimed adhesion to a variety of common substrates, including metals, ceramics and filled plastics

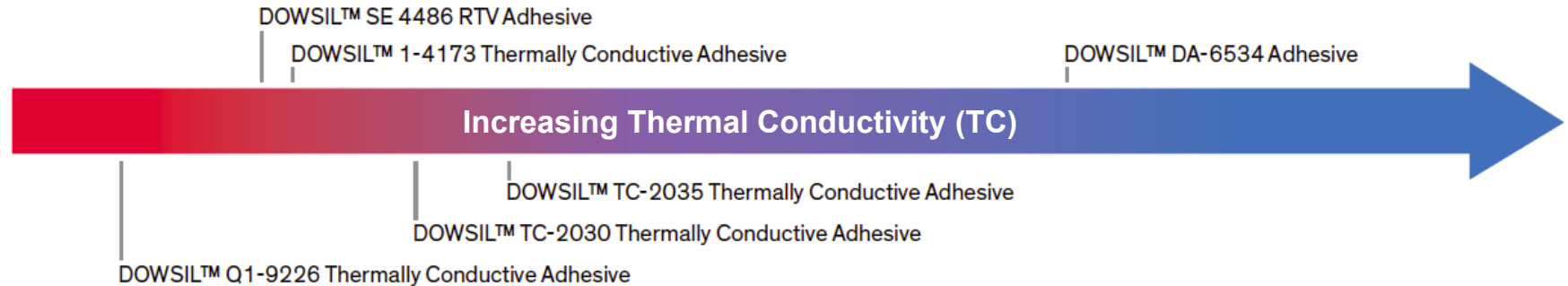


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Applications: Thermally Conductive *Adhesives*

Typical Applications

Bonding and sealing of hybrid circuit substrates, semiconductor components, heat spreaders and other applications that demand broad design, flexible processing options and excellent thermal management.



Overview: Thermally Conductive Compounds

Description

- Serve as thermal bridges that draw heat away from a device's sensitive PCB module components and dissipate it into the ambient environment
- No-cure materials

Benefits

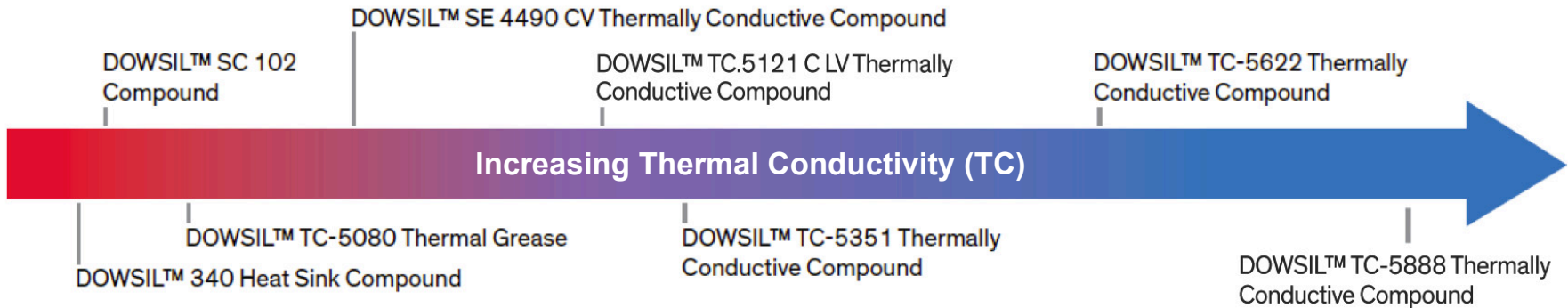
- Low thermal resistance
- High thermal conductivity
- Ability to achieve very thin bond line thickness
- Relatively low cost
- Easy application onto heat sinks via screen printing; ease of rework
- Maintain consistency at high temperatures to form positive seals with heat sinks, ensuring reliable device performance
- Particularly suitable for applications in which heat sinks are removed and reattached later, or where the PCB module assembly favors no-cure processes



Applications: Thermally Conductive *Compounds*

Typical Applications

Sensitive PCB module components, LED lighting application, Power application such as IGBT module, telecom equipment, consumer electronics, power supplies and power components for transportation, etc



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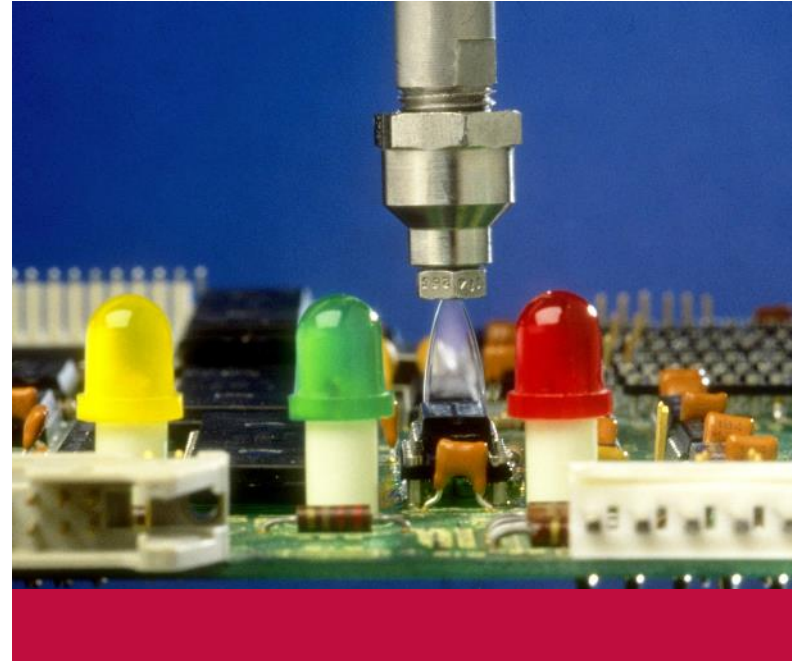
Overview: Thermally Conductive *Elastomers & Gels*

Description

- Adaptable products for encapsulation and potting applications
- Broad family of material technologies offers versatile thermal management solutions
- Available in a range of hardness and stress relief levels

Benefits

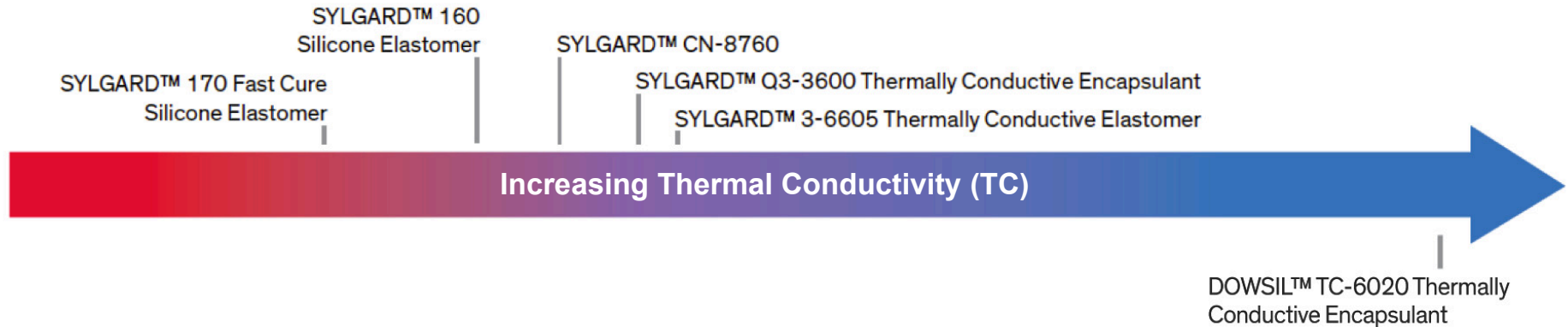
- Low viscosity before cure of these products enables easy processing; fully embed tall components, delicate wires and solder joints
- Particularly suitable for managing high heat in complicated PCB architectures
- Extremely low modulus after cure; provides superb stress-relief



Applications: Thermally Conductive *Elastomers & Gels*

Typical Applications

PCB system architectures, Potting of high-voltage transformers and sensors;
assembly of substrates to heat sinks; gap fill material between heat sources and heat sinks Potting for:
On-board charger, Inverter, Converter, Transformer, etc



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Thermally Conductive Materials Product Summary

Noncurable Products	Thermal Conductivity (W/mK)	Adhesive	Thin BLT TIM (<100 µm)	Gap Filler (>100 µm) Large Joint Movement and Damping Needs	Encapsulant/ Pottant
DOWSIL™ 340 Heat Sink Compound	0.7		•		
DOWSIL™ SC 102 Compound	0.9		•		
DOWSIL™ TC-5080 Thermal Grease	1.0		•	•	
DOWSIL™ SE 4490 CV Thermally Conductive Compound	1.6		•	•	
DOWSIL™ SC-4471 CV Thermally Conductive Compound	2.0		•		
DOWSIL™ TC-5121 C LV Thermally Conductive Compound	2.9		•		
DOWSIL™ TC-5026 Thermally Conductive Compound	2.9		•		
DOWSIL™ TC-5351 Thermally Conductive Compound	3.3			•	
DOWSIL™ TC-5622 Thermally Conductive Compound	4.3		•		
DOWSIL™ TC-5888 Thermally Conductive Compound	5.2		•		

Increasing TC

This list is not all-inclusive. If you do not see a product that meets your needs, please contact your Dow representative.



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Thermally Conductive Materials Product Summary *(continued)*

One-Part Curable Elastomer Products	Thermal Conductivity (W/mK)	Adhesive	Thin BLT TIM (<100 µm)	Gap Filler (>100 µm) Large Joint Movement and Damping Needs	Encapsulant/ Pottant
DOWSIL™ EA-9189 H White RTV Adhesive†	0.88	●	●		
DOWSIL™ TC-1500 Adhesive†	1.55	●	●		
DOWSIL™ SE 4486 RTV Sealant†	1.59	●	●		
DOWSIL™ 3-6752 Thermally Conductive Adhesive	1.69	●	●		
DOWSIL™ 1-4174 Thermally Conductive Adhesive*	1.78	●	●		
DOWSIL™ 1-4173 Thermally Conductive Adhesive	1.81	●	●		
DOWSIL™ SE 4485 Thermally Conductive Adhesive†	2.80	●	●		
DOWSIL™ DA-6534 Adhesive**	6.80	●	●		

Increasing TC

†Moisture-cure product. *Contains glass spacer beads for bond line thickness (BLT) control. **Provides electrical conductivity. This list is not all-inclusive. If you do not see a product that meets your needs, please contact your Dow representative.



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Thermally Conductive Materials Product Summary *(continued)*

Two-Part Curable Elastomer Products	Thermal Conductivity (W/mK)	Increasing TC ↓	Adhesive	Thin BLT TIM (<100 µm)	Gap Filler (>100 µm) Large Joint Movement and Damping Needs	Encapsulant/ Pottant
SYLGARD™ 170 Fast Cure Silicone Elastomer	0.40					•
SYLGARD™ 170 Silicone Elastomer	0.48					•
SYLGARD™ 160 Silicone Elastomer	0.62					•
DOWSIL™ CN-8760	0.66					•
DOWSIL™ Q1-9226 Thermally Conductive Adhesive	0.8		•	•		
SYLGARD™ Q3-3600 Thermally Conductive Encapsulant	0.92		•			•
SYLGARD™ 3-6605 Thermally Conductive Elastomer	0.85		•	•		•
DOWSIL™ 3-6751 Thermally Conductive Adhesive	1.0		•	•		
DOWSIL™ TC-4515 Thermally Conductive Gap Filler	> 1.8				•	
DOWSIL™ TC-4525 Thermally Conductive Gap Filler	2.6				•	
DOWSIL™ TC-2030 Adhesive	2.7		•		•	
DOWSIL™ TC-6020 Thermally Conductive Encapsulant	2.72					•
DOWSIL™ TC-4535 CV Thermally Conductive Gap Filler	3.5				•	
DOWSIL™ TC-2035 Adhesive	3.3		•	•		

*Contains glass spacer beads for bond line thickness (BLT) control.

This list is not all-inclusive. If you do not see a product that meets your needs, please contact your Dow representative.

Silicone Foams (FIPFG)

- Uses
- Typical applications
- Processing
- Flowability
- Typical properties

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Uses of Silicone Foams (FIPFG)

Ideal for use when:

- A compression gasket is required
- An “environmental seal” is required (sealing against ambient air, splashed water, dust, moisture)
- A cost-effective sealing solution is required (compared to preformed gaskets/foam tapes)
- High-tolerance gaps exist
- Low sealing force/low modulus is required
- Component sound and vibration require damping
- Gasket installation demands automation (robotic dispensing)
- Serviceability is an issue
- Installation at tier supplier is preferred
- Fast cure (room temperature/low heat) is demanded



Typical Applications of Silicone Foams

- Back caps for headlamps/taillights
- Headlamps/taillights/brake lights
- Housings for PCB system assemblies
- Timing belt covers
- Plastic covers under the hood (“beauty covers”)
- Door modules
- Almost anywhere foam tape is used



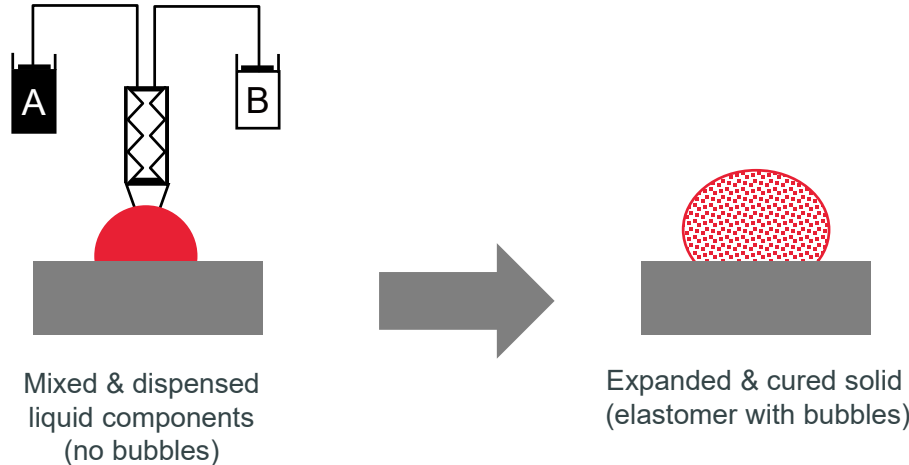
Typical Applications of Silicone Foams *(continued)*

- Ceramic hobs and supporting metal frames
- Dishwasher detergent dispenser units
- Outdoor lighting
- Gas boilers



Processing of Silicone Foams

- A two-part silicone RTV foam is directly dispensed onto the part surface to be sealed
- Once the components are mixed, a foaming agent (H_2) is formed
- The dispensed foam gasket expands in its liquid stage and cures to a foamed solid (elastomer) within 10 minutes at room temperature
- Provides a low-modulus integrated compression seal with fine cell-structure



Flowability of Silicone Foams

Difference between flowable and reduced-flow foams:



Typical Properties of Silicone Foams

Product Property	SILASTIC™ 8257 Silicone Foam	SILASTIC™ 8257 Silicone Foam (black)	DOWSIL™ 3-8209 Silicone Foam	DOWSIL™ 3-8219 RF Silicone Foam Kit	DOWSIL™ 3-8259 RF Silicone Foam Kit	DOWSIL™ 3-8259 RF Silicone Foam Kit (dark gray)
Viscosity, mPas	A: 21,000 B: 12,000	A: 20,000 B: 12,000	A: 14,000 B: 15,000	A: 21,000 B: 40,000	A: 68,000 B: 63,000	A: 64,000 B: 62,000
Snap time, sec	230	240	220	200	200	200
Tack free time, min	8	8	7	6	7	6
Density, kg/m ³	140	150	250	300	330	330
Flowability, cm	– Flowable	– Flowable	– Flowable	17	15	16
Cell structure, Zellen/3cm	35	30	Fine	Fine	Fine	Fine
Hardness, Shore 00	25	25	45	45	50	50

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