2P-RTV Silicone Foam Gasket for FIPFG Applications

Dow Corning Corporation
Presentation topics

1. Dow Corning silicone foams: Appearance / samples
2. Dow Corning FIPFG applications
3. Dow Corning FIPFG processing
4. Curing of Dow Corning silicone foams
5. Product properties of Dow Corning silicone foams
1. Dow Corning silicone foams: Appearance / samples
1. Dow Corning silicone foams: Appearance / samples

Silicone Adhesives/Sealants

RTV
Room Temperature Vulcanizing Products
- 1-part RTV Moisture Cure
  - Acetoxy Cure
  - Alkoxy Cure
- 2-part RTV No Moisture Cure
  - Oxime Cure
  - Silicone Reactive Hotmelt

HTV
Heat Cure Materials
- 1-part Heat Cure Adhesives
- 2-part Heat Cure Adhesives
  - Alkoxy Cure
  - Silicone Foam
    - Compression Gaskets
  - 2-part CIPG Cured In Place Gaskets
2. Dow Corning FIPFG applications

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 requires dampening

• Gasket installation demands automation (robotic dispensing)

• Serviceability is an issue

• Installation at tiered supplier is preferred

• Fast-cure (room-temp / low heat) is demanded
2. Dow Corning FIPFG applications

- Back caps for head lamps / tail lights
- Head lamps / tail lights / break lights
- Housings for electric devices
- Timing belt cover
- Plastic cover under the Bonnett (“Beauty Covers”)
- Door modules
- Almost anywhere foam tape is used!
2. Dow Corning FIPFG applications

- Supporting metal frame of ceramic hobs
- Ceramic hobs
- Dishwasher detergent dispenser unit

- Outdoor lighting
- Gas boiler
3. Dow Corning FIPFG processing

- A two part silicone RTV foam is directly dispensed onto the part surface to be sealed
- Once the components are mixed, a foaming agent (H₂) is formed
- The dispensed foam gasket expands in its liquid stage and cures to a foamed solid (elastomere) within 10 minutes at room-temperature.
- Provides a low modulus integrated compression seal with fine cell-structure
3. Dow Corning FIPFG processing

1. Application
   Robotic application of 2-part RTV silicone foam

2. Curing at RT (optional at elevated temp.)
   Expansion of the gasket

3. Finished Part
   Part can be handled after approx. 10 min.

4. Assembly
   Part can be assembled after 15 min., preferably 1h

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3. Dow Corning FIPFG processing

Dow Corning DFG products are being applied via commercial available meter-/mix units directly onto the part to be sealed. The meter-/mix equipment consists out of:

- Product supply pumps, incl. refill unit
- Product conditioning unit (air nucleation, recirculation)
- Metering pumps (precise flow control)
- Mixing chamber (dynamic or static)
- Robot (6-axis robot or xyz-table)
- Parts conveyor belt or shuttle table
- Part fixturing

Dispensing unit
Pressurized tanks or recirculation Conditioning unit

Conveyor belt
Part loading
Robotic application

Heating tunnel (optional)

Finished parts
3. Dow Corning FIPFG processing

Static mixing
- Cheaper equipment
- No solvents required
- Mixer is easily moved around contoured parts
- Process conditions very much depend on product temperature and throughput
- Production process more critical due to issues of purging to waste and dripping

Dynamic mixing
- Mixing efficiency depends on ratio shear to friction
- Typically components are “preconditioned” (temperature controlled, pre-loaded with dry air)
- More robust and flexible process
- Less waste during production stops
- Higher capital investment

Dynamic static mixing
- The two components are mixed via “rotating static mixer elements“
- In between static and dynamic mixing process
- Higher throughput than static mixing
- Less expansive than dynamic mixing
4. Curing of Dow Corning silicone foams

Once the components A&B are mixed, the following reactions occur:

1. Hydrogen Formation
2. Formation of gas cells and cell growth (Foam Expansion)
3. Curing (Formation of the elastomeric network)

All reactions are temperature dependent, but at different rate constants.

To ensure a homogeneous cell size distribution, a proper mixing of the components is essential.
4. Curing of Dow Corning silicone foams

Foaming mechanism

\[ \equiv \text{Si-OH} + \equiv \text{Si-H} \rightarrow \equiv \text{Si-O-Si} \equiv \]

\[ \text{R-OH} \quad \text{R-O-Si} \equiv \quad + \quad \text{H}_2 \uparrow \]

- Dow Corning DFG products create the foaming gas during the crosslinking reaction (hydrogen as by-product)
- Typical amount of $\text{H}_2$ evolved: 0.5 - 1.3 g / kg Product
- Typical expansion ratio: 1:2.5 to 1:4
- To ensure optimal foam structure a good mixing of the components is required
- In case of dynamic mixing air nucleation is typically recommended
4. Curing of Dow Corning silicone foams

Curing mechanism

\[
\text{Polymer} \quad + \quad \text{Crosslinker} \quad \rightarrow \quad \text{3 dimensional network} \quad \text{Elastomere}
\]

- Dow Corning DFG materials are addition cure products containing Pt-catalysts.
- Certain chemicals, curing agents and plasticizers can inhibit cure.
- These include:
  - Sulphur / Polysulphones / Polysulfides / Sulphur containing materials
  - Organo-tin compounds / silicone rubber containing organo-tin catalysts
  - Amines / Amides
  - Urethanes
  - Azides
# 5. Product properties of Dow Corning silicone foams

## Typical product properties

<table>
<thead>
<tr>
<th>Product Property</th>
<th>8257</th>
<th>8257 black</th>
<th>3-8209</th>
<th>3-8219 RF</th>
<th>3-8259 RF</th>
<th>3-8259 RF dark grey</th>
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<td></td>
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<td>Flowability [cm]</td>
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</table>
5. Product properties of Dow Corning silicone foams

Influence of flow characteristics on the aspect ratio

Material as dispensed → Cured gasket

Flowable foam e.g. 3-8209
h/b ratio ~ 1/3

Reduced flowable foam e.g. 3-8259 RF
h/b ratio ~ 1/2
5. Product properties of Dow Corning silicone foams

Difference of flowable and reduced flowable foams
5. Product properties of Dow Corning silicone foams

Compression set / compression stress relaxation

\[
CompressionSet [\%] = \left(\frac{A - C}{A - B}\right) \times 100
\]

A = Sample Height before Storage
B = Sample Height under Compression
C = Sample Height after Storage

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Compression set / compression stress relaxation (CSR)

\[
CSR[\%] = \left( \frac{F_{after}}{F_{before}} \right) \times 100
\]

\( F_{after} \) = Counterforce after Storage

\( F_{before} \) = Counterforce before Storage

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5. Product properties of Dow Corning silicone foams

Compression set / compression stress relaxation (CSR)  
22h / 70°C / 50% compression

<table>
<thead>
<tr>
<th>Property Product</th>
<th>Comp. Set [%] NPC</th>
<th>Comp. Set [%] PC 1h 100°C</th>
<th>CSR [%] NPC</th>
<th>CSR [%] PC 1h 100°C</th>
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</table>
5. Product properties of Dow Corning silicone foams

Compression stress deflection

- According to: DIN EN ISO 3386-1
- Setup values: Compression of 70% in 4 cycles with a specified speed
- Measured values: Stress as function of compression
- Result values: 1. Diagram stress against compression
                2. Stress measured during the 4th cycle at 40% compression
## 5. Product properties of Dow Corning silicone foams

### Compression stress deflection

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<tr>
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<th>D</th>
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<th>CCmax</th>
<th>CRef</th>
<th>Cmax</th>
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<td>[kPa]</td>
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<td>[mm]</td>
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![Graph showing compression stress deflection](Image)
5. Product properties of Dow Corning silicone foams

![Graph showing properties of Dow Corning silicone foams](image)

PC 1h 100°C

NPC

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DMTA dynamic mechanical thermal analysis

- Dynamic means  -> stress on sample is oscillating
- Mechanical means -> stress on sample is compression (or tensile or shear …)
- Thermal means   -> test runs with temperature profiles

→ it applies ... an oscillating compression
→ it measures ... the resulting forces / stress

Storage Modulus       it’s a value for elastic behavior
Loss Modulus          it’s a value for viscos behavior
Loss Factor tan δ     it’s the relation between loss & storage modulus
5. Product properties of Dow Corning silicone foams

DMTA Temperature sweep
5. Product properties of Dow Corning silicone foams

Adhesion of Dow Corning silicone foams

• DFG materials generally do NOT develop adhesion to metal and plastic substrates
• If higher degree of adhesion is required, surface treatments such as cold plasma, corona, primer or flame treatment are recommended
• Part design considerations such as grooves and channels can also improve adhesion (mechanical stay-in-place adhesion due to expansion of gasket bead)
• Adhesion may be less successful on low energy plastics such as polyethylene or PTFE
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