The Engineer's Guide to Low Outgassing Adhesives

How to select the right low outgassing adhesive

MASTERBOND®
ADHESIVES | SEALANTS | COATINGS

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Why Low Outgassing Adhesives Matter

The aerospace, electronic, and optical industries often involve environments where outgassing from adhesives can pose significant challenges. This is particularly true in the space industry, where the extreme environment of space can cause conventional adhesives to release volatile compounds. Historically, the space industry addressed this concern by performing tests in thermal-vacuum cham bers to simulate the harsh conditions of space and determine if polymers were suitable for spacecraft applications. These tests laid the foundation for the development of low outgassing adhesives, which minimize the release of volatile substances and ensure the integrity and performance of sensitive components across various demanding operating conditions.

NEGATIVE IMPACT OF OUTGASSING		
AEROSPACE	**ELECTRONIC**	**OPTICAL**
In a spacecraft, outgassed materials can contaminate localized atmosphere	Outgassed substances can corrode delicate electronic components	Outgassing can cloud optical lenses and create performance issues

BROADER IMPACT - Beyond these industries, low outgassing adhesives are critical in any applications where even minor contamination from outgassing can compromise the performance and reliability of sensitive components.

How Can Low Outgassing Adhesives Benefit Your Application

Reduced Contamination

Low outgassing properties significantly reduce the risk of depositing contaminated residue on nearby surfaces, which can degrade critical components.

Enhanced Vacuum Integrity

Low outgassing adhesives are specially formulated to minimize the release of volatile compounds in vacuum conditions, making them ideal in high-vacuum environments where purity is critical.

Compliance with Stringent Industry Standards

Utilizing low outgassing adhesives ensures compliance with demanding industry standards, such as ASTM E595, used by NASA for screening materials for space use. This compliance is crucial for projects requiring high reliability and longevity.

Improved Equipment Lifespan

By minimizing the accumulation of outgassed materials in confined spaces, these adhesives contribute to the longer operational lifespan of mechanical systems, reducing maintenance and replacement costs.

Testing Adhesive Compounds for NASA Low Outgassing Standards

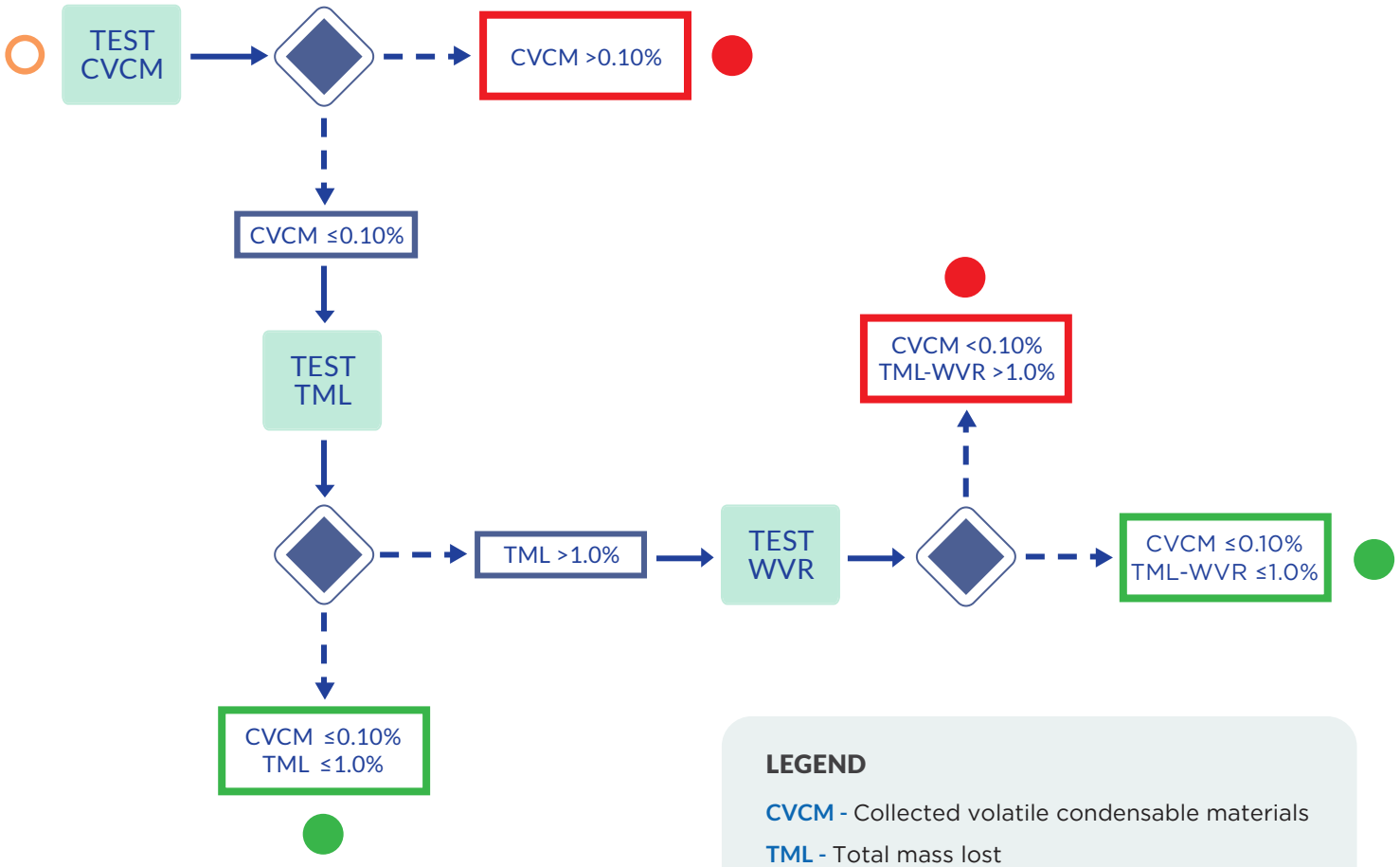
The ASTM E595 standard, initially developed by NASA, serves as a benchmark for assessing the outgassing characteristics of materials. This method is widely adopted across various industries to ensure material compatibility and reliability in environments where minimal outgassing is critical. Design engineers are encouraged to explore the process of ASTM E595 testing in order to fully understand under what circumstances compounds are considered to be low outgassing.

Process of ASTM E595 NASA Low Outgassing Test

An industry standard test procedure, "Total Mass Lost (TML) and Collected Volatile Condensable Materials (CVCM) from Outgassing in a Vacuum Environment," was developed by NASA to determine the mass lost in a vacuum and to collect the outgassed products. This procedure, known as ASTM E595, measures the volatile content of polymeric materials placed in a heated vacuum chamber.

1. **Test specimens are preconditioned at 25°C, 50% humidity, and standard atmospheric pressure for 24 hours to ensure common pretreatment**
2. **Samples are weighed and placed into individual compartments within a solid copper heater bar, with a separate cover for each compartment**
3. **Collector plates are placed at a distance of 0.5 inches from small exit ports that come from each cover - providing only one channel for escaped volatile gasses to accumulate**
4. **The heater bar is then placed within the test chamber, where the pressure is set to 5×10^{-5} torr or less**
5. **Both the samples and the copper bar are heated to 125°C for 24 hours, driving off volatile gasses, which are forced through the exit port**

With the temperature of the collector plates set to 25°C, a significant portion of the volatile material condenses on the plate. The TML for each specimen is calculated as a percentage by comparing the weight of the specimen before and after the test period. The CVCM for each specimen is calculated as a percentage by comparing the weight of the clean collector plate to that of the collector plate after the test period.



Test Results

PASS

If the CVCM does not exceed 0.10% and the TML does not exceed 1.0%, the material passes the test

FAIL

If the CVCM exceeds 0.10% — regardless of the TML value — the material fails the test

FURTHER ANALYSIS REQUIRED

If the CVCM does not exceed 0.10%, but the TML exceeds 1.0%, a further measurement is made to determine the mass of water vapor regained by the specimen after reconditioning exposure to a 50% relative humidity atmosphere at 25°C for an additional 24 hours. The water vapor regained (WVR), expressed as a percentage, represents the mass of water vapor recovered compared to the mass of the original specimen. If the difference between the TML and the WVR does not exceed 1.0% (and the CVCM does not exceed 0.10%), the material passes the test.

Selecting the Right Low Outgassing Adhesive for Your Application

When evaluating adhesive options, design engineers should prioritize the specific properties of the product based on their application requirements. Understanding the unique characteristics and performance attributes of each product is important for selecting the most suitable adhesive for the intended application. By focusing on the specific properties and performance capabilities of each product, engineers can make informed decisions to optimize the performance and reliability of their designs.

APPLICATIONS

BONDING	**COATING**	**IMPREGNATING/ POROSITY SEALING**
SEALING	**POTTING/ ENCAPSULATION**	**CASTING**

ADHESIVE CHEMISTRIES

EPOXIES	**SILCIONES**	**UV CURING COMPOUNDS**
• Superior strength • Chemical resistance • Excellent reliability	• Flexibility • Thermally stablity • Moisture resistance	• Fast curing times • Optical clarity • Active alignment capability

PERFORMANCE PROPERTIES

STRENGTH	**MECHANICAL**	**ELECTRICAL**
• Lap shear • Tensile • Modulus	• Elongation • Hardness • Dimensional stability	• Electrically insulation • Electrically conductivity
THERMAL	**CHEMICAL**	**OPTICAL**
• Service temperature range • Thermal conductivity • Thermal cycling resistance	RESISTANT TO: • Acids and bases • Fuels and oils • Organic and inorganic solvents	• Light transmission • Optical clarity • Variety of colors

PROCESSING & HANDLING CONSIDERATIONS

CURE TIME	**CURE TEMPERATURE**	**VISCOSITY**

Explore Our Top Low Outgassing Adhesives: Performance Properties, Applications & Resources

At Master Bond, we understand the crucial role of low outgassing compounds in ensuring project success and offer a comprehensive line of low outgassing epoxies, silicones and UV/LED light curable systems.

- Adhesives featuring a wide range of performance properties
- Case studies covering real-life applications
- References to technical data sheets, videos, infographics and other information

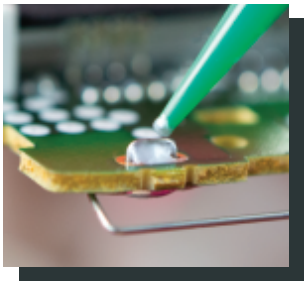
Product	Chemistry	APPLICATIONS			PROPERTIES					Page Number
		Bonding/ Sealing	Coating	Potting/ Encapsulation	Electrically Insulative	Electrically Conductive	Thermally Conductive	Optically Clear	Cryogenic	
EP3HTS-TC	One part epoxy	✓	✓			✓	✓			8
EP4S-80	One part epoxy	✓	✓			✓	✓			9
EP17HTDA-1	One part epoxy	✓			✓		✓			10
Supreme 10HT	One part epoxy	✓			✓					11
EP21TCHT-1	Two part epoxy	✓			✓		✓		✓	12
EP21TDC-2LO	Two part epoxy	✓	✓	✓	✓		✓		✓	13
EP29LPSP	Two part epoxy	✓	✓	✓	✓			✓	✓	14
EP30-2	Two part epoxy	✓	✓	✓	✓			✓	✓	15
EP37-3FLFAO	Two part epoxy	✓	✓	✓	✓		✓		✓	16
Supreme 121AO	Two part epoxy	✓	✓	✓	✓		✓			17
MasterSil 920-LO	One part silicone		✓		✓			✓		18
MasterSil 151S	Two part silicone	✓	✓			✓	✓			19
MasterSil 323AO-LO	Two part silicone	✓			✓		✓			20
UV16	UV curing	✓	✓		✓			✓		21
UV22DC80-1	UV (dual) curing	✓	✓	✓	✓			✓		22

All products listed in this guide meet both of the following standards:

- **NASA low outgassing according to ASTM E595 testing**
- **RoHS compliance restricting the use of specific hazardous materials**

EP3HTS-TC

Thermally conductive, NASA low outgassing silver filled epoxy



EP3HTS-TC is a fast curing, one part epoxy that utilizes a non-sintering silver technology to provide ultra high heat transfer capability. It can be used for sealing and coating, however, its main use is as an adhesive for die attach and general bonding purposes. Additionally, it is recommended in applications where the lowest possible volume resistivity is required.

Key Features

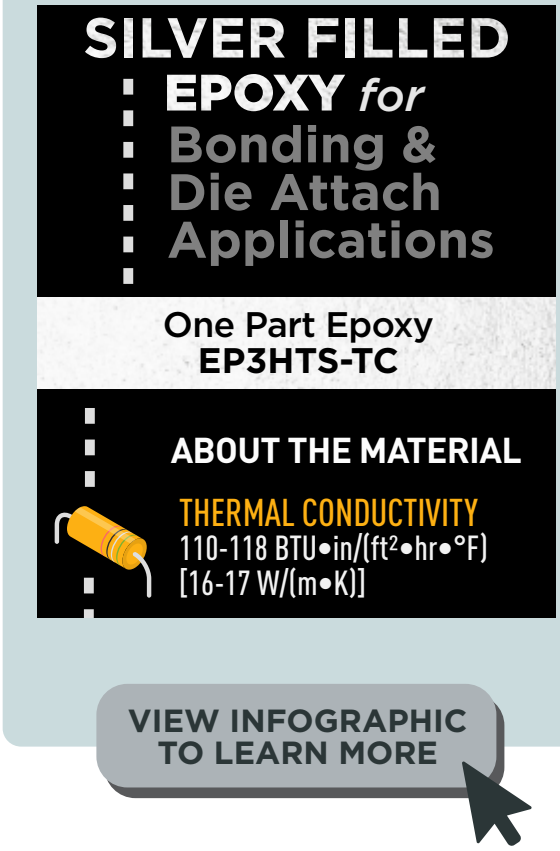
- For bonding, sealing and coating
- Not premixed and frozen
- Very long open time at room temperature
- Cures rapidly at 250-300°F
- Outstanding electrical and thermal conductivity

REQUEST A TDS for EP3HTS-TC

Packaging Options

Jars

Syringes



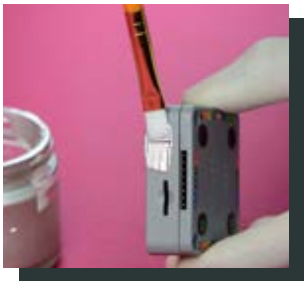
VIEW INFOGRAPHIC TO LEARN MORE

PERFORMANCE PROPERTIES OF EP3HTS-TC

Volume resistivity, 75°F	<0.001 ohm-cm
Hardness, 75°F	60-70 Shore D
Die shear strength, 75°F (2 x 2 mm [80 x 80 mil])	9-12 kg-f
Service temperature range	-80°F to +400°F [-62°C to +204°C]

EP4S-80

Silver filled epoxy with a curing temperature of 80°C

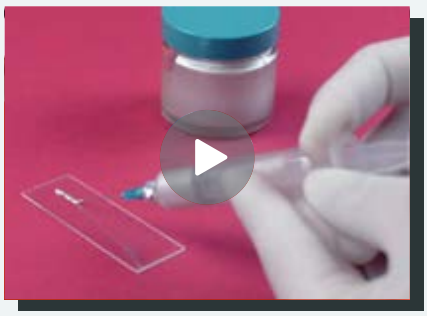


EP4S-80 is a one component, silver filled epoxy for bonding, sealing and coating, that requires heat to cure. It is low in viscosity and flows smoothly and easily. This high modulus, high compressive strength system also features excellent electrical conductivity.

Key Features

- Low viscosity
- Curing temperature 80°C
- Glass transition temperature 130-135°C
- Good electrical conductivity

REQUEST A TDS for EP4S-80



See EP4S-80 in action in this video demonstration

WATCH NOW

PERFORMANCE PROPERTIES FOR EP4S-80

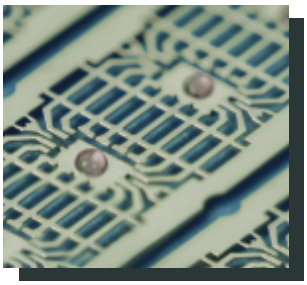
Volume resistivity, 75°F	<0.001 ohm-cm
Thermal conductivity, 75°F	9-10 BTU•in/(ft²•hr•°F) [1.30-1.44 W/(m•K)]
Hardness, 25°C	75-85 Shore D
Service temperature range	-76 to +302°F [-60°C to +150°C]

Packaging Options

Jar **Syringe**

EP17HTDA-1

High temperature resistant epoxy for die attach applications



Formulated for die attach applications, EP17HTDA-1 is a one component epoxy that can also be used for bonding and sealing. It has a high glass transition temperature (Tg). This product offers excellent electrical insulation properties, even at elevated temperatures, and has a low exotherm upon curing.

Key Features

- Tacks in 5 to 10 minutes at 150°C
- Thermally conductive, electrically insulative
- Excellent die shear strength
- High temperature resistance
- One part, no mix system

MIL-STD 883J

Meets MIL-STD-883J standard for thermal stability

REQUEST A TDS for EP17HTDA-1

Case Study: Used in air-microfluidic particulate matter sensor for wearable devices

EP17HTDA-1 provided researchers from the University of Illinois at Chicago and the University of California at Berkley with the right viscosity flow profile for die attaching in their wearable device application. The epoxy's high die shear strength helped to ensure reliable sensor assembly.

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Packaging Options

Syringe

SUPREME 10HT

Toughened, high strength epoxy system

For bonding applications requiring exceptional shear and peel strength, Supreme 10HT delivers outstanding performance for both similar and dissimilar substrates. This one part heat cured, toughened epoxy offers unlimited working life, resists mechanical and thermal shocks, and withstands 1,000 hours 85°C/85% RH.

Key Features

- No mix, single component system
- Serviceable from 4K to +400°F
- Unlimited working life at room temperature
- Resists mechanical and thermal shocks

LAP SHEAR STRENGTH

Aluminum to Titanium

4727 psi

Aluminum to Stainless Steel

4066 psi

Nickel to Titanium

3422 psi

REQUEST A TDS for Supreme 10HT

85°C 85%RH

Meets 85°C + 85% Humidity Testing standard

Case Study: Utilized in structural bonding for supersonic aircraft, electronics packaging and capacitor tanks

Discover the versatility of Supreme 10HT through these case studies, showcasing the adhesive's application in cutting-edge industries. The system has been shown to be exceptionally strong, durable, and tough over a wide range of temperatures and after repeated thermal cycling. It performs well with both similar and dissimilar substrates.

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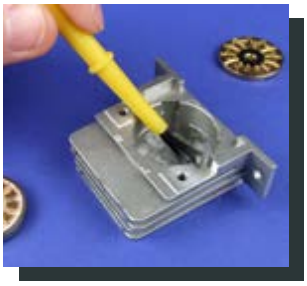
EP21TCHT-1

Rigid, thermally conductive epoxy for service up To 400°F



Curable at room temperatures, EP21TCHT-1 has high thermal conductivity and superior electrical insulation properties. It has a service operating temperature range of 4K to 400°F, and a very low thermal expansion coefficient. It is recommended for use in vacuum environments, particularly those where only slightly elevated temperature cures are possible.

Key Features

- Thermally conductive, electrically insulative system
- Cryogenically serviceable
- Low coefficient of thermal expansion
- Easy to apply, paste consistency

MIL-STD 810G — Meets MIL-STD-810G standard for fungus resistance

85°C 85%RH — Meets 85°C + 85% Humidity Testing standard

REQUEST A TDS for EP21TCHT-1

Case Study: Used in telescopes, laser packaging assembly & magnet bonding

EP21TCHT-1 has been used in various applications involving different substrates, service conditions and requirements. Discover why researchers from the University of Florida, Princeton University, NASA, and other institutions have selected this system for its impressive performance capabilities, which have contributed to the successful implementation in their projects.

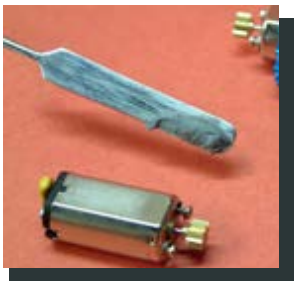
DOWNLOAD NOW

Learn more about the impressive properties of EP21TCHT-1 in this video

WATCH NOW

EP21TDC-2LO

Highly flexibilized, thermally conductive epoxy



EP21TDC-2LO offers high flexibility, toughness, and thermal shock resistance. It has a long working life with low exotherm during curing, making it suitable for use in thick as well as in thin sectioned configurations. It is electrically insulative and thermally conductive, and cryogenically serviceable down to 4K.

Key Features

- Electrically insulating, thermally conductive
- High peel strength and elongation
- Easy to apply
- Excellent flexibility
- Cryogenically serviceable down to 4K

MIL-STD 810G — Meets MIL-STD-810G standard for fungus resistance

85°C 85%RH — Meets 85°C + 85% Humidity Testing standard

REQUEST A TDS for EP21TDC-2LO

Case Study: Adhesive for optical components in laser and space applications

For military and aerospace applications, the stability of bonding agents plays a fundamental role in ensuring mission success when bonded structures face extremes in temperature, vibration, or acceleration. See how Master Bond EP21TDC-2LO demonstrated its ability to maintain structural integrity under the harshest conditions in these 2 case studies.

DOWNLOAD NOW

Packaging Options

- Cans
- Premixed & Frozen Syringe
- Pails

EP29LPSP

Low viscosity, cryogenically serviceable epoxy system

EP29LPSP is a two part, modified low temperature heat cured epoxy for cryogenic applications. Optically clear and serviceable at temperatures as low as 4K, it may be used as an adhesive, sealant and protective coating. It withstands cryogenic shocks from room temperature to liquid helium temperatures in a 5-10 minute time period.

Key Features

- Optically clear
- Electrically insulative
- Superior physical strength properties
- Withstands cryogenic shock
- Low mixed viscosity

PERFORMANCE PROPERTIES

Volume resistivity, 75°F
$>10^{15}$ ohm-cm

Tensile modulus, 75°F
>400,000 psi

Hardness, 75°F
>65 Shore D

Service temperature range
4K to +275°F [4K to +135°C]

REQUEST A TDS for EP29LPSP

Case Study: Applications in plasma physics, astronomy, highway engineering and more

In over a dozen published research articles, patents, and manufacturers' specifications, scientists and engineers have utilized EP29LPSP in applications for neuroscience, particle physics, aeronautics and more. The system was chosen for its suitability in cryogenic conditions, physical strength, electrical insulation, and chemical resistance.

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Packaging Options

Cans

Pails

Premixed & Frozen Syringe

EP30-2

Optically clear, high strength epoxy compound

EP30-2 is a lower viscosity, two component epoxy system combining a high strength profile, excellent electrical insulation, and dimensional stability. This structural system can be used for small potting and encapsulations, as well as in cryogenic applications.

Key Features

- Optically clear, transmits light
- Superb physical strength properties
- Cryogenic serviceability
- Rigid curing system
- Can be used for small potting and encapsulation applications

85°C
85%RH

Meets 85°C + 85% Humidity Testing standard

REQUEST A TDS for EP30-2

VIEW INFOGRAPHIC TO LEARN MORE

Packaging Options

- Cans
- Double Barrel Cartridge
- Gun Applicator
- Premixed & Frozen Syringe
- Pails

EP37-3FLFAO

PPasses fungus resistance per MIL-STD-810G standard

EP37-3FLFAO is a two component system for high performance potting, bonding, sealing and coating. It features high thermal conductivity, excellent electrical insulation, good physical strength and a high degree of flexibility. Once cured, the epoxy resists shock, vibration, impact and thermal cycling.

Key Features

- High flexibility
- Thermally conductive, electrically insulative
- High bond strength to a wide variety of substrates
- Low viscosity with excellent flowability; ideal for potting & casting
- Cryogenically serviceable down to 4K

MIL-STD 810G **Meets MIL-STD-810G standard for fungus resistance**

85°C 85%RH **Meets 85°C + 85% Humidity Testing standard**

REQUEST A TDS for EP37-3FLAO

PERFORMANCE PROPERTIES FOR EP37-3FLAO

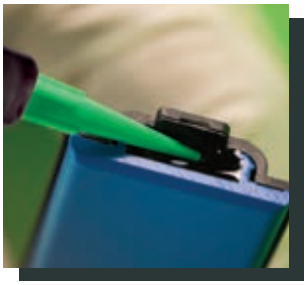
Thermal conductivity, 75°F	9-10 BTU•in/(ft²•hr•°F) [1.30-1.44 W/(m•K)]
Dielectric strength, 75°F (1/8 inch thick test specimen)	450 volts/mil
Hardness after 1,000 hours 85°C/85% RH	43 Shore D
Service temperature range	4K to +250°F [4K to +121°C]

Packaging Options

Cans **Pails** **Premixed & Frozen Syringe**

SUPREME 121AO

Potting compound resists high temperatures



Supreme 121AO is a heat curing epoxy featuring excellent thermal conductivity and high temperature resistance. This system flows readily after mixing, and has a very long open time of 5-7 days. It is well suited for potting and encapsulation applications.

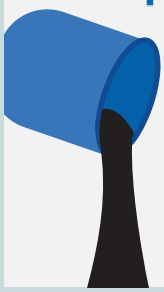
Key Features

- Good flow combined with long working life
- Thermally conductive, electrically insulative
- Superior physical strength properties & toughness

FREE FLOWING ENCAPSULANT

meets

NASA Low Outgassing Specifications



THERMAL STABILITY

Glass transition temperature
200-210°C

Temperature resistance
Up to +550°F

REQUEST A TDS for Supreme 121AO

VIEW INFOGRAPHIC TO LEARN MORE

Packaging Options

Cans

Jars

Premixed & Frozen Syringe

PERFORMANCE PROPERTIES FOR SUPREME 121AO

Volume resistivity, 25°C	$>10^{14}$ ohm-cm
Thermal conductivity, 75°F	4-5 BTU•in/(ft^2•hr•°F) [0.58-0.72 W/(m•K)]
Hardness, 75°F	85-95 Shore D
Service temperature range	-80°F to +550°F [-62°C to +288°C]

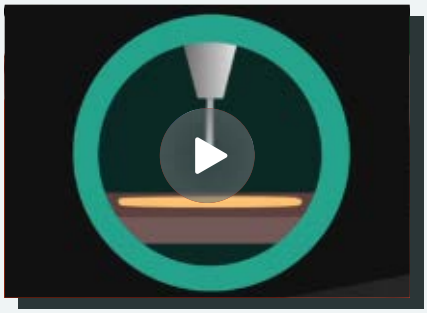
MASTERSIL 920-LO

Low stress, optically clear, one part silicone

MasterSil 920-LO is a high performance, room temperature vulcanizing silicone for sealing, coating and small encapsulations. This single component system has a moderate, flowable viscosity and a solid electrical profile, which makes it well suited for conformal coating applications in the electronic and optical industries. It also exhibits superior temperature resistance and low stress.

Key Features

- Moderate viscosity with good flow properties
- Neutral, non-corrosive cure
- Superb optical clarity
- Soft durometer



Learn more about MasterSil 920-LO in this video

WATCH NOW

Packaging Options

Tube

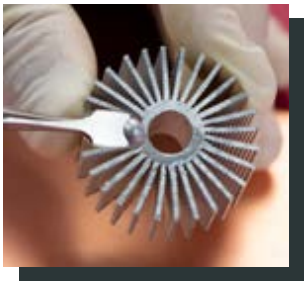
REQUEST A TDS for MasterSil 920-LO

PERFORMANCE PROPERTIES FOR MasterSil 920-LO

Hardness, 75°F	25-35 Shore A
Volume resistivity, 75°F	>10^{15} ohm-cm
Refractive index, 75°F	1.43
Service temperature range	-175°F to +500°F [-115°C to +260°C]

MASTERSIL 151S

Silver conductive, low outgassing silicone adhesive



Two part MasterSil 151S is a silver filled silicone with superb electrical conductivity and good heat transfer properties. Upon mixing, it has a smooth, paste consistency, and can be easily applied as an adhesive, sealant, coating, or as a form-in-place conductive gasketing material. It cures readily in thicknesses up to and beyond 1/4 inch thick.

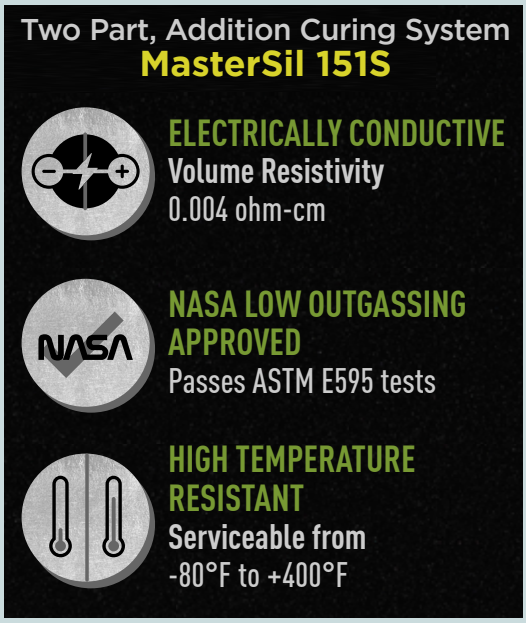
Key Features

- Excellent electrical conductivity
- Addition cured type system
- Highly flexible & temperature resistant
- Exceptionally long working life
- Paste consistency

Packaging Options

Jars

REQUEST A TDS for MasterSil 151S



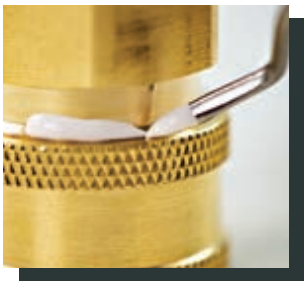
VIEW INFOGRAPHIC TO LEARN MORE

PERFORMANCE PROPERTIES FOR MasterSil 151S

Thermal conductivity, 75°F	9-11 BTU•in/(ft²•hr•°F) [1.30-1.59 W/(m•K)]
Tensile strength, 75°F	400-700 psi
Elongation, 75°F	100-150%
Service temperature range	-80°F to +400°F [-62°C to +204°C]

MASTERSIL 323AO-LO

Thermally conductive, electrically non-conductive silicone



MasterSil 323AO-LO is a two part silicone elastomer with a self-priming feature. Electrically insulating and thermally conductive, this compound is used for bonding and sealing. Its paste-like consistency also allows it to be used as a gap filling material where minimum flow is needed.

Key Features

- Convenient 1 to 1 mix ratio
- High viscosity, flowable
- High bond strength
- Thermally conductive, electrically insulative

REQUEST A TDS for MasterSil 323AO-LO

Silicone Compounds Meet NASA Low Outgassing Specifications

Learn more about Master Bond's one and two component high performance silicone formulations that pass NASA ASTM E595 testing

LEARN MORE

PERFORMANCE PROPERTIES FOR MasterSil 323AO-LO

Thermal conductivity, 75°F	8-9 BTU•in/(ft^2•hr•°F) [1.15-1.30 W/(m•K)]
Tensile modulus, 75°F	500-700 psi
Elongation, 75°F	50-60%
Service temperature range	-65°F to +400°F [-54°C to +204.5°C]

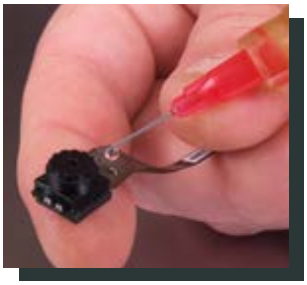
Packaging Options

Cans

Pails

UV16

Low viscosity UV curable epoxy compound



UV16 is a low viscosity, high strength epoxy based UV curable system for bonding, sealing and coating. It is a one part system that cures quickly and easily with a commercial UV light source. It provides optical clarity and dimensional stability.

Key Features

- Good physical strength properties
- Low shrinkage upon curing
- Cationic curing system, no oxygen inhibition
- One component system, no mixing needed
- Superior temperature resistance
- Outstanding optical clarity
- High bond strength

REQUEST A TDS for UV16

Packaging Options

Can

Pail

Syringe

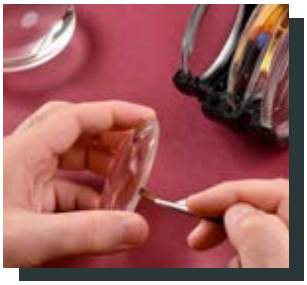
Case Study: Utilized in Bonding Applications for Microring Resonators, Optical Waveguides and Confocal Microscopes

The properties of UV16, such as low viscosity, low shrinkage, and low refractive index, make it an excellent choice for many applications, including resonance extinction and biomedical products. This case study highlights 3 commercial and research uses for UV16, a one part cationic curing system, that cures tack free and is not oxygen inhibited.

DOWNLOAD NOW

UV22DC80-1

Nanosilica filled, dual curing (UV light + heat) adhesive



UV22DC80-1 is a one part, optically clear, nanosilica filled epoxy based system for bonding, sealing and coating with the ability to cure under UV light and/or with heat. It is electrically insulative, abrasion resistant, dimensionally stable, and has low shrinkage upon cure.

Key Features

- Low viscosity
- Minimal shrinkage upon curing
- Superb optical clarity
- Cures at 80°C in shadowed out areas

See UV22DC80-1 in action in this video demonstration

WATCH NOW

REQUEST A TDS for UV22DC80-1

Packaging Options

Can

Jar

Syringe

PERFORMANCE PROPERTIES FOR UV22DC80-1

Volume resistivity, 75°F	>10^{14} ohm-cm
Refractive index, 75°F	1.52
Tensile modulus, 75°F	>750,000 psi
Service temperature range	-100°F to +350°F [-73°C to +177°C]

Contact Us

Materials that successfully meet NASA's low outgassing criteria are suitable for a wide range of uses, encompassing space missions, specialized optical, electronic and defense applications, among others. We presently offer over 70 formulations of low outgassing adhesives. The team of chemists at Master Bond is constantly pursuing the development of new formulations to meet the increasing demands of these industries.

Our technical staff has decades of expertise in solving application problems. Every incoming inquiry is assigned to an experienced technical representative who will work with you throughout the design, prototyping and manufacturing processes. We take special pride in the personal “one on one” support we provide.

Connect with our adhesive specialists today to discuss your specific needs!

DISCUSS YOUR APPLICATION

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