

# SILICONE ADHESIVES

RTV and HEAT CURE silicone adhesives for  
sealing, bonding and thermal management.

## Overview

Adhesives come in a wide range of chemistries each having its specialist properties and applications. In this context silicones are often referred to as sealants rather than adhesives, which lead many people to the conclusion that they will not perform as an adhesive.

Adhesives require certain properties, good adhesion to a required substrate, physical strength to avoid cohesive failure, resistance to environmental conditions and the ability to maintain these properties over a given lifetime.

A sealant on the other hand may only require limited adhesion, with little physical strength, but must be resistant to the environmental conditions it is exposed to.

If careful attention is given to product selection with the specific application in mind, silicones can perform as both adhesives and sealants, thereby making them a very versatile and cost effective solution in a wide variety applications.

- ▶ Silicone elastomers in general have these general physical properties:
- ▶ Wide operating temperature range -115 to 316°C
- ▶ Excellent electrical properties
- ▶ Flexibility
- ▶ UV resistance
- ▶ Good chemical resistance
- ▶ Resistant to humidity and water
- ▶ No or low toxicity

Silicone adhesive sealants use two basic silicone chemistries:

### Condensation cure

These use moisture in the atmosphere to trigger the curing process at room temperature and are commonly referred to as Room Temperature Vulcanising (RTV's). These are normally supplied as 1-part systems although they can be formulated as 2-parts for fast curing systems.

### Addition cure

These require heat to initiate the curing process; and this technology can be supplied as either 1 or 2-part systems.

## RTV Silicone Adhesive Sealants

This type of silicone chemistry is the most widely used in the formulating of silicone adhesive sealants utilising the moisture in the atmosphere to react with chemical cross linkers, thereby enabling the formation of a silicone elastomer. They are normally described in terms of the small amount of the chemical by-product produced during the reaction.

The most common systems are:

- ▶ **Acetoxy**
- ▶ **Oxime**
- ▶ **Alkoxy or Methoxy**
- ▶ **Acetone**

All these alternative cure mechanisms will lead to the formation of an elastic and relatively tough silicone rubber however, some of the final physical properties of these rubbers will be substantially different. The chemical by-products have an impact on the products suitability for certain applications and will also affect the way the adhesive can be handled from a Health and Safety standpoint.



Cure Mechanism	By- Product	Advantages	Disadvantages
Acetoxy	Acetic Acid	Good Adhesion High Temperature +300°C Fast Cure (3mm 4-14 hrs)	Corrosive Pungent Odour
Acetone	Acetone	Non-Corrosive Good Adhesion High Temperature +300°C Fast Cure (3mm 8-24 hrs) No H&S Issues	Not Suitable for Acrylics or Polycarbonate
Alkoxy / Methoxy	Ethanol or Methanol	Good Adhesion Non- Corrosive Mil specifications High Temperature +315°C	Slower Cure
Oxime	Pentanone oxime	Good Adhesion to Plastics Low Corrosive	Not suitable for Acrylics or Polycarbonate and direct contact with copper

As the above chart shows, each curing system has some advantages and disadvantages. It is therefore, important to consider the materials being used, the operating environment and the production methods employed before you select your RTV. Acetone cure silicones adhesives have many technical advantages they are now being specified for a wide variety of applications especially within electronics.

## 1-Part Condensation Cure RTV

RTV's are extremely flexible and user friendly. Application can be made using handheld tubes and cartridge guns or fully automated dispensing systems utilizing pails or drums. It is not possible to adjust cure speeds using heat; using temperatures above 40°C during the curing process can have detrimental effects, the cure speed and skin over time is a feature of the chemical formulation. However, it is possible to adjust the curing regime through changes to the chemistry and CHT have successfully tailored many formulations to meet individual customer's requirements, subject to commercial considerations.

1-Part condensation cure (RTV) products should not be used to produce a seal more than 10mm thick, because the silicone will cure to form a moisture proof membrane which will prevent any curing below 10mm. If it is necessary to create a seal greater than 10mm using a 1-Part RTV, the seal should be built up in layers of approx 5mm, allowing time for each section to cure before applying the next layer.

It is also important to ensure a minimum thickness of at least 1mm to allow sufficient liquid material to form the chemical bonds within the elastomer; this will create a stable rubber with strong chemical adhesion.

Correct storage is important as exposure to moisture will induce premature curing of the adhesive.

## 1-Part Addition Cure

These heat cured silicone adhesive sealants are particularly useful where production methods demand very fast cure times or when there is a need to apply the material and have a delay before curing, perhaps to carry out other assembly procedures.

The chemistry used is based upon a platinum catalyst which is, in effect, retarded and only starts to work when heat is applied. Most 1-part addition cures require temperatures above 80°C to cure the material, by elevating the temperature the cure speed will increase to a maximum temperature of approx 150°C.

Adhesion is normally a little harder to achieve using these materials when compared with RTV's. Adhesion promoters are added to improve adhesion, but these normally require the use of higher temperatures for slightly longer periods of time. For example, a typical adhesive may cure after 30 minutes at 100°C while elevating the temperature to 150°C for 30 minutes will ensure adequate adhesion to the substrate.

The platinum catalyst is susceptible to attack from certain chemical compounds which in turn will lead to inhibition of cure, resulting in a partially cured product. Bringing the uncured material into contact with the following chemical compounds should be avoided during the manufacturing process; nitrogen, sulphur, phosphorus, arsenic, organotin catalysts, PVC stabilizers; epoxy resin catalysts, sulphur vulcanised rubbers, and condensation cure silicone rubbers. \* It is worth noting that CHT Alkoxy, RTV's do not cause inhibition.

## Physical Properties

The physical properties of both addition and condensation cure silicones can be modified by adjusting the formulation. Some of these properties affect the uncured material and are usually factors which are determined by the production process or product design. Other properties relate to the cured adhesive or elastomer and functionality or operating conditions.

Some of the physical properties are interrelated so adjustments made to accommodate one parameter may impact upon another property. Many of the physical properties can be adjusted and the list below summarises some of the basic properties and what they define. CHT routinely test its materials using a wide variety of test methods.

### Properties of the Uncured Material

**Rheology** – defining the flow characteristics of the uncured material.

**Paste** – a non-slump material that maintains its profile.

**Flowable** – a liquid that will find its own level.

**Semi-flowable** – displays a limited amount of fluidity.

**Thixotropic** – flows when under pressure but will then hold its profile.

**Viscosity** – measures the force required to move the uncured liquid.

Viscosity will affect the ability of the material to flow in and around a component and its suitability for automatic dispensing systems.

**Skin time** – time taken for the material to form a touch dry skin.

Skin time is an important measurement as the adhesive must be in contact with any surface that you require it to adhere to before it starts to skin over.

**Cure time** – time taken for a given section of adhesive to cure through.

With all RTV's the chemical reaction will continue after the given cure time for several days, before all the given physical properties have been reached. For this reason, caution is needed before testing or exerting undue demands on the adhesive. Although the product may be ready for use or the next part of the production process, sufficient time should be allowed for all the physical properties to develop.

Addition cured adhesives will be fully cured and have all their physical properties once the initial cure has been achieved.

## Properties of a Cured Elastomer

**Hardness** – the final hardness of a cured rubber.

This will affect its suitability for use as a compression gasket, its ability to withstand thermal expansion or suppress vibration.

**Elongation** – the percentage of elongation before the cured rubber snaps.

**Tear** – force required to tear a sheet of cured elastomer.

**Tensile Strength** – force required to break the cured elastomer when under tension.

**Temperature Resistance** – the range within which the adhesive will retain its physical properties.

The ability to withstand very wide temperature ranges is closely linked to the choice of silicone polymer and the cross-linking system used. However, increased temperature resistance can be achieved through the addition of special fillers such as iron oxide.

**Thermal Conductivity** – measuring the capacity of the elastomer to transmit heat.

By adding speciality fillers to the silicone polymers, it is possible to produce adhesives that will dissipate heat.

**Electrical Conductivity** – measuring the amount of electrical resistance.

Silicones by nature are electrical insulators with high resistivity but through the addition of conductive fillers it is possible to produce materials that will conduct or dissipate electricity.

## Typical Applications

It is not possible to produce a definitive list of applications as the versatility of these adhesives enables their use in almost every industry.

**Electronics** – sealing cables, electrical boxes, fixing components, attaching heats EMI shielding, sealing sensors, conductive gaskets.

**Automotive** – under bonnet electronics, vibration protection, making gaskets & seals, sealing sensors.

**Aerospace** – high temperature bonding, sealing electronics, conductive gaskets, vibration protection.

**Photovoltaic** – bonding PV modules into frame, attaching control boxes, sealing boxes.

**LED's** – attaching heat sinks, sealing PCB's, attaching components, sealing enclosures.

**Domestic Appliances** – attaching door hinges to oven doors, sealing hobs.

**Food Industry** – sealing kitchens, sealing ducting.



**Lighting** – bonding lenses, covers and fire proofing.

**Solar Energy** – sealing solar collectors.

**Construction** – glazing, bathroom sealants, sealing joints.

**Engineering** – gaskets, general adhesive & sealing.

**Marine** – sealing window hatches, safety lighting,

**Rubber Industry** – bonding silicone rubber.



For further specific application details refer to CHT Silicones Application Pages



## High Specification RTV's

### Silcoset RTV Silicone Adhesives

The Silcoset brand name has an enviable reputation within the aerospace industry. Originally manufactured by ICI Chemicals over 25 years ago, these Acetoxy based silicone RTV's were some of the first to be developed for very high specification applications. Leading aerospace companies have been specifying their use in their aero engines for many years, being selected for their ability to withstand temperatures of – 60°C to +300°C.

**The Silcoset Range has the following approvals:**

ADHESIVE	AFS	NATO
Silcoset 151	1540B	5970-99-224-1408
Silcoset 152	1540B	8030-99-225-0551
Silcoset 153	1543B	8030-99-225-0471
Silcoset 158	1540B	

### MIL-A-46146B Specification RTV Silicone Adhesives

CHT have formulated both a paste and flowable versions to meet the MIL-A-46146B specification these products have the following properties:

- ▶ Very high tensile strength up to 7.75 MPa
- ▶ Extremely high temperature resistance up to +316°C
- ▶ Excellent adhesion to most metals and plastics
- ▶ Neutral cure - no harmful by-products

ADHESIVE	DESCRIPTION
AS1740	1 Part Non-Corrosive Neutral Cure Flowable
AS1745G	1 Part Non-Corrosive Neutral Cure Paste Grey

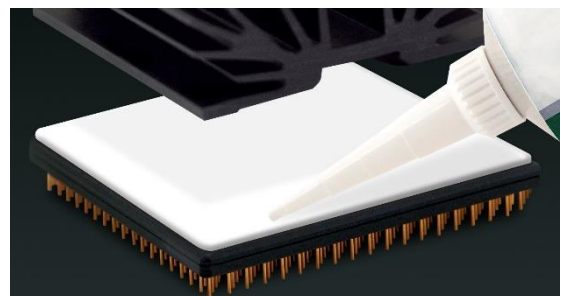
### Thermally Conductive Silicone Adhesives

The addition of specialty fillers to silicone polymers retain the physical properties of the silicone adding the benefit of thermal transfer. The resulting silicone adhesive is still flexible and resistant to harsh environments and the long-term effects of exposure to high temperatures.

Heat can be dissipated effectively away from processors, power units, LED's and other components to improve performance and extend product life. Silicone adhesives can also be used to improve heat conduction in sensors, radiators and other thermal devices. The range includes UL approved products.

#### General Attributes:

- ▶ High thermal conductivities
- ▶ Choice of heat or room temperature cure
- ▶ Range of maximum working temperatures up to 300°C
- ▶ Range of rheology's and viscosities



## A selection of CHT adhesives

ADHESIVE	DESCRIPTION
AS1700	Non-corrosive, neutral alkoxy curing adhesive with excellent dielectric and isolating properties
AS1706	Non-corrosive, neutral alkoxy curing sealant with good thermal conductivity, UL 94 V0 listed
AS1723	Non-corrosive, neutral alkoxy curing adhesive
AS1803	Non-corrosive, neutral acetone curing, thermally conductive paste RTV, excellent adhesion
AS1811	Non-corrosive, neutral acetone curing, highly thermal conductive sealant Thermal Interface Material with UL 94 V0 classification

CHT have a very extensive range of silicone adhesives, many are tailored to meet specific physical parameters. To view all CHT Silicone Adhesives visit and to find view individual Technical Data Sheets please visit <https://cht-silicones.com/products/adhesives>

Our technical service team have extensive application-based knowledge and are always available to discuss and assist you with your application. If needed and subject to technical and commercial considerations CHT can offer bespoke formulations to meet your exact requirements.





**CHT**

SMART CHEMISTRY  
WITH CHARACTER.

CHT Germany GmbH | Bismarckstraße 102 | D-72072 Tübingen  
Tel +49 7071 154-0 | Fax +49 7071 154-290 | [www.cht.com](http://www.cht.com) | [info@cht.com](mailto:info@cht.com)

[www.cht.com](http://www.cht.com)

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