

## Silicone Adhesive Sealants

Adhesives come in a wide array 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:

Firstly, condensation cure, which uses moisture in the atmosphere to trigger the curing process this will take place at room temperature. These are commonly referred to as RTV's, meaning Room Temperature Vulcanising. These are normally supplied as 1-part systems although they can be formulated as 2-parts for fast curing systems.

Secondly, addition cure, which requires heat to initiate the curing process, 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	Methylethylketoxime	Good Adhesion to Plastics Low Corrosive	H&S Issues Low Exposure Levels

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 hand held 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 we 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.

### **2-Part Condensation Cure RTV**

These fast curing silicone adhesives use a 10:1 twin pack cartridge and a static mixer. As they are RTV's they do not need heat and will cure at room temperature allowing components to be handled in less than 60 minutes. They come in a standard 246ml cartridge but can also be supplied in pails or drums to facilitate automatic dispensing.



Production times and costs can be reduced when compared to standard 1-Part RTV Silicone adhesives. There is no need to install expensive heating systems or ovens. They will also exhibit anaerobic cure that is they do

not need atmospheric moisture to complete the cure. They can therefore be used in deep sections not normally possible with conventional RTV's.

We have formulated both Acetone and Alkoxy cured accelerated cure adhesives and a thermally conductive version for use in electronics.

## **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 their materials using a wide variety of test methods.

### **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 adhesive will be fully cured and have all their physical properties once the initial cure has been achieved.

**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, after a small cut has been made.**

**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 ranges of temperature 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 specialist fillers to the silicone polymers it is possible to produce adhesives that will dissipate heat.

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

Silicones are by nature 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 electrical 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** – sealing lenses, bonding covers, sealing cables, fire proofing.

**Solar Energy** – sealing solar collectors.

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

**Engineering** – making 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 Sheets*

## **High Specification RTV's**

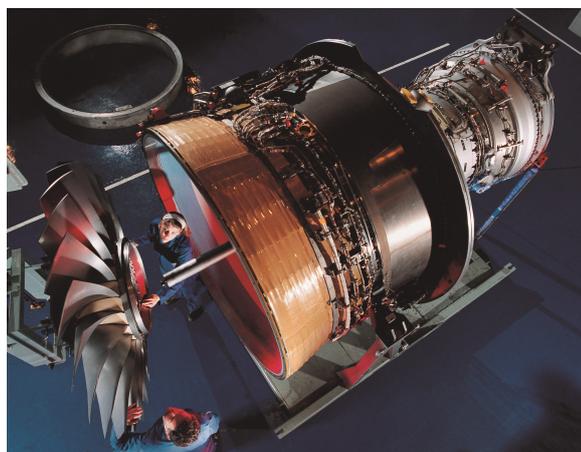
### **Silcoset RTV Silicone Adhesives**

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. Rolls Royce Aerospace has 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.

They are also approved for use by NATO and the MOD.

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

	<b>AFS</b>	<b>NATO</b>	<b>R R MSSR</b>
Silcoset 151	1540B	5970-99-224-1408	9085
Silcoset 152	1540B	8030-99-225-0551	9146
Silcoset 153	1543B	8030-99-225-0471	9410
Silcoset 158	1540B		9146



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

CHT 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

**To view CHT's complete Silicone Adhesives portfolio, please visit:**

<https://cht-silicones.com/products/adhesives>