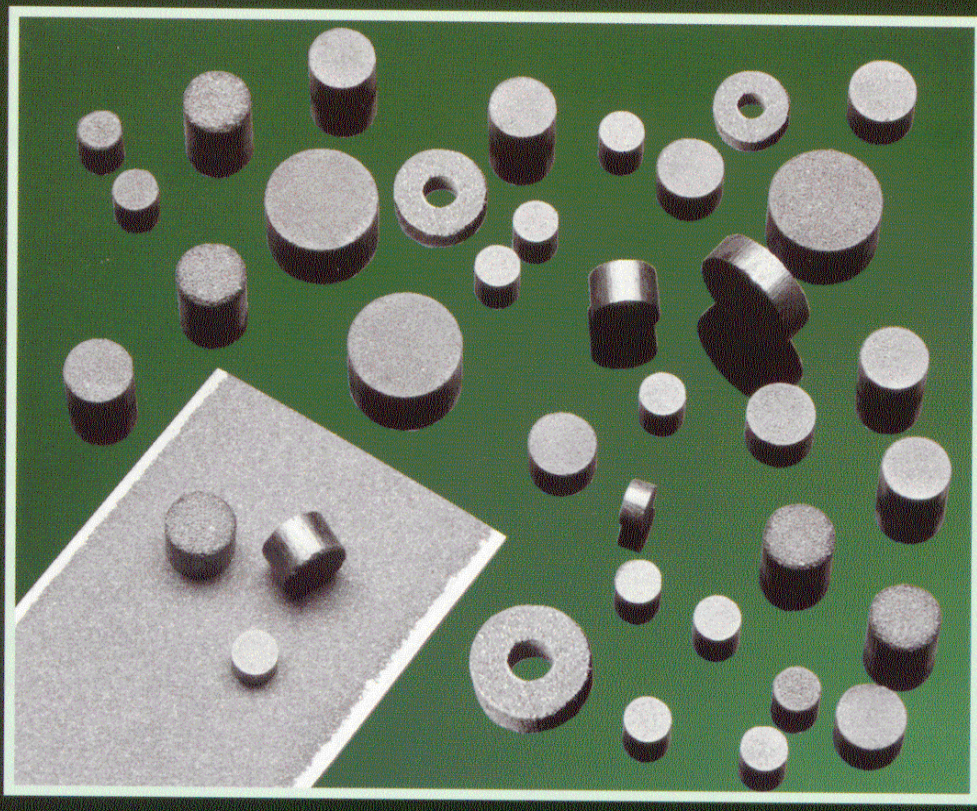


St 707™

**NON EVAPORABLE GETTERS
ACTIVATABLE AT LOW
TEMPERATURES**



The SAES Getters Group has been the world leader in the production of non evaporable getters since the early 1960s. Using a variety of metal alloys, SAES Getters manufactures products for a large number of different applications.

SAES Getters long recognized the need for a getter material that could be activated around 400°C, a temperature commonly used in industrial and laboratory processes, having the additional advantage of a wide operating temperature range, including room temperature. Hence, a dedicated research project led to the development of St 707.

The St 707 Getter Alloy

The St 707 getter material is a ternary alloy whose nominal composition is :

Zirconium : 70 %
Vanadium : 24.6 %
Iron : 5.4 %

This alloy is fully activated in the temperature range of 400°C to 500°C, making it an appropriate material for:

- Applications in which the getter can be activated concurrently with the device's bakeout, eliminating the need for a specific activation procedure. In this situation, the St 707 getter can be used as an in-situ pump to shorten processing time.
- Applications where the heat load from getter activation has to be minimized.
- Metal envelope devices in which activation temperatures can be attained by direct contact with the heated walls.

St 707's gettering performance, considerable in the 20°C to 100°C range, has been used successfully at cryogenic temperatures.

The St 707 alloy is available in the following forms:

- Compressed into pills or washers
- Deposited and firmly fixed on thin metallic strips
- As a component in porous, sintered getters, i.e., St 172*

Getters made with St 707 are stable under recommended handling conditions.

They can be used in industrial applications with modest precautions aimed at preventing getter contamination during assembly, cleaning procedures, and heating in air.

St 707 is also one of the getter materials used in SAES Getters pumps and purifiers.* Many projects have been made possible due to St 707 alloy ultra high-vacuum compatible characteristics.

Proven applications of St 707 as a getters are:

- Metallic thermos bottles
- Industrial dewars
- Particle accelerators
- Evacuated jackets
- Plasma fusion machines
- Evacuated solar collectors

Applications of St 707 as an active material are:

- Inert gas purifiers
- Handling and storage of hydrogen and its isotopes

* See specific catalogues

Getter Activation

St 707 getters have a protective passivation layer, formed during production through a controlled process. This protective layer must be eliminated to start the gettering action and allow gas molecules to react with the alloy.

To accomplish this, the getter is heated under vacuum to a sufficiently high temperature for a short time. This process, called activation, causes the passive film to diffuse into the bulk of the getter, making the surface active for sorption.

It is essential to heat the getter under a vacuum of 10^{-3} torr or better, or in an inert gas atmosphere. This prevents an accumulation of sorbed gas molecules on the active surface of the getter, which can otherwise build up a passivation layer and stop the gettering action.

Optimum conditions to achieve full getter activation are:

- **Getter temperature** = $450 \pm 50^{\circ}\text{C}$
- **Heating time** ~ 10 minutes

These conditions are not mandatory. It is possible to heat the St 707 getter to higher temperatures, requiring shorter times for activation. Lower heating (from 300°C to 400°C) temperatures applied for a longer period of time, can also ensure a full getter activation.

When a low activation temperature (from 200°C to 300°C) is used, full activation is not reached, resulting in only a partial depassivation of the getter surface. Because of this, the gettering rate (a measure of getter efficiency in capturing gas molecules) and the surface available for sorption, will be reduced. The bulk getter capacity, however, will not be affected.

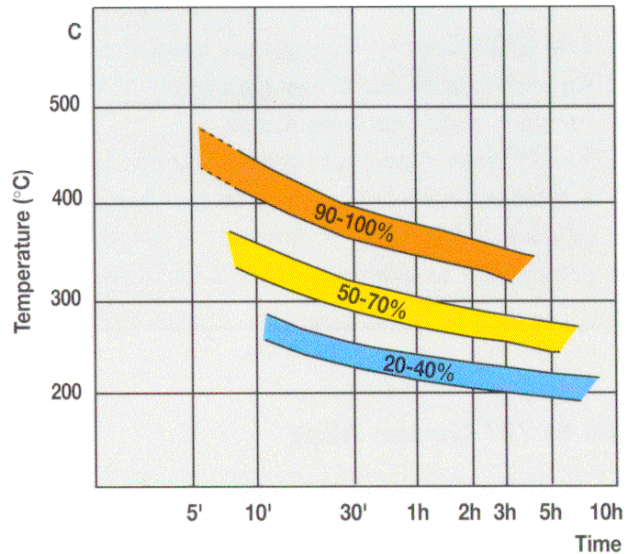


Fig. 1. Activation conditions and gettering efficiency of St 707

Fig. 1 illustrates different activation conditions related to St 707 gettering efficiency.*

Heating the getter is typically done by conventional methods (induction heating, passage of electric current or contact with hot metallic surfaces). In applications in which vacuum baking between 250°C and 450°C is part of the process, partial or full activation of the St 707 getter is possible, exploiting the baking process itself. In this case, in-situ pumping action in addition to that of the main pumping system, is provided by the getter, thus substantially shortening process pumping time.

*Efficiency is expressed as a percentage of the initial pumping speed of a getter activated at 450°C for 10 minutes (standard activation).

St 707 Getter Operation

Once the St 707 getter is activated, active gaseous impurities such as H₂, H₂O, CO, CO₂ and N₂ which contact the surface, are captured and chemisorbed onto the getter. Hydrocarbons are sorbed at low pumping speed when the getter temperature is above 200°C. Only inert gas atoms are not sorbed.

To take advantage of the getter's full capacity, it is necessary to diffuse the chemisorbed atoms into the body of the getter. This diffusive action should take place quickly, so any possible accumulation of adsorbed species cannot form a passive layer, retarding the sorption process. Individual species diffuse into the St 707 bulk following an exponential function of the temperature and the square root of time, whose equation follows:

$$\text{Diffusion quantity} = A \cdot e^{-\frac{B}{T}} \cdot \sqrt{\text{time}}$$

where:

A and **B** are constants

T = temperature in degrees Kelvin

This indicates that the predominant parameter regulating the dynamics of diffusion into the alloy bulk is the temperature. The higher the temperature, the faster is the diffusion.

For St 707, operating temperatures of approximately 200 °C to 250°C and above ensure a diffusion rate sufficient to avoid passivation layer formation, thus allowing utilization of the full getter capacity. However, when operating at lower temperatures, only the surface of the getter material is available for sorption. St 707 getter capacity at low temperatures is still sufficient for most applications. When sorption occurs at low temperatures, a reactivation process may be used to renew sorption capacity.

To reactivate the getter the initial activation conditions can be repeated.

Once sorbed, oxygen, carbon and nitrogen atoms cannot be released again by the St 707, even at very high temperatures, due to the formation of strong chemical bonds with the alloy atoms. These atoms are diffused into the bulk of the getter until a complete saturation occurs.

Hydrogen atoms react differently, however. They diffuse into the St 707 getter body more quickly than other atoms and distribute almost uniformly within the bulk even at low temperatures. In addition, because of the relatively weak forces that bind these atoms to the alloy, some of the hydrogen sorbed at low temperatures can be released at higher temperatures. In other words, hydrogen sorption is reversible.

Fig. 2 illustrates hydrogen equilibrium pressures at the indicated temperatures and concentrations.

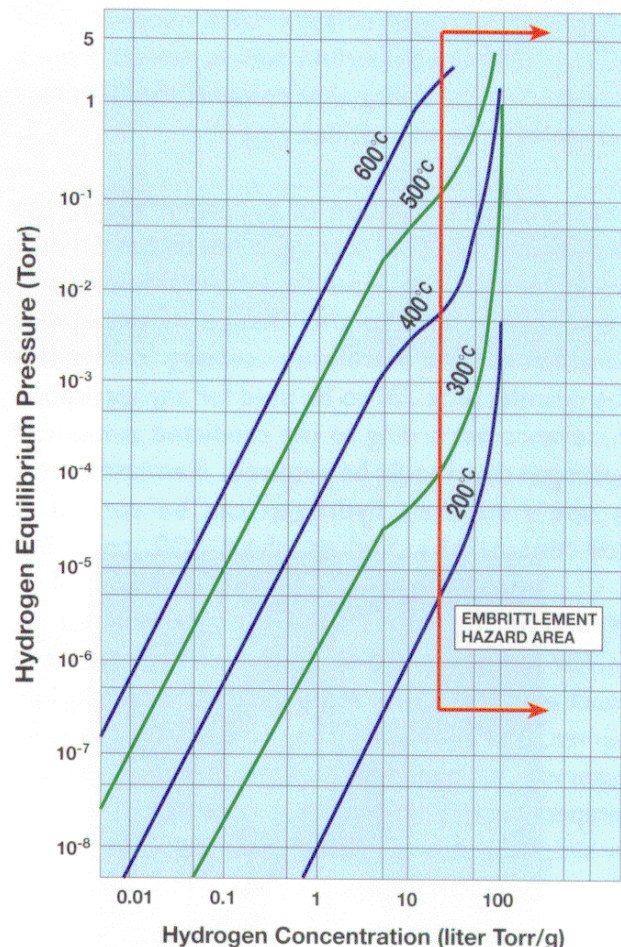


Fig. 2 . Hydrogen equilibrium isotherms of the St 707 getter alloy

It also shows that for a hydrogen concentration up to about 10 torr l/g of St 707, the corresponding H₂ equilibrium pressure over the getter at different temperatures follows Sieverts' Law, which specifically for the St 707 alloy is:

$$\log P = 4.8 + 2 \log Q - \frac{6116}{T}$$

where:

P = H₂ equilibrium pressure in torr

Q = concentration of H₂ within the alloy in torr l/g

T = temperature in degrees Kelvin

When the hydrogen concentration exceeds about 10 torr l/g, the equilibrium curves deviate from a straight line indicating that some of the dissolved gas starts to form hydrides.

Excessive accumulation of hydrogen within the St 707 alloy bulk (>20 torr l/g) is not recommended, because this can lead to embrittlement and particulation due to the change of the lattice parameters. It is therefore necessary to calculate the quantity of St 707 to be used for any application in advance, according to the predicted amount of hydrogen that should be gettered. If embrittlement is not a concern, hydrogen can be sorbed at concentrations higher than 100 torr l/g.

Hydrogen isotopes (D₂, T₂) are sorbed by St 707 in the same way as normal hydrogen and react identically with slightly different equilibrium curves. This allows the alloy to be used as a solid reservoir for hydrogen isotopes. Adsorbed at low temperatures, hydrogen and its isotopes are released by simply heating the getter from 500°C to 900°C, depending upon the application.

Sorption Performance of the St 707 Getter Alloy

To show the gettering performance of St 707, three typical test gases have been selected: CO, N₂ and H₂, the most common residual gases within vacuum devices.

The suggested operating temperature of St 707 getters is between 25°C and 350°C. Fig. 3 presents the gettering performance, sorption speed vs. amount of gas sorbed at these two temperatures, as well as at the frequently used intermediate temperature of 280°C.

St 707 powder alloy: 100mg

Geometric surface: 50 mm²

Activation: 450°C for 10 min.

Sorption: At the indicated temperatures

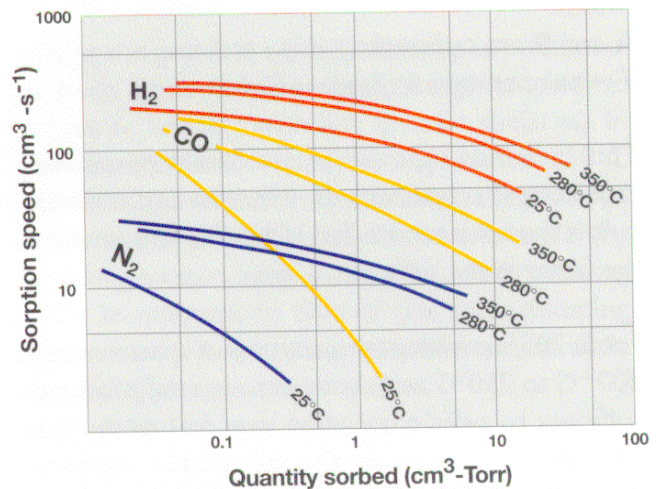


Fig. 3. Sorption characteristics of St 707 for H₂, CO and N₂ at various temperatures

To significantly increase the indicated performance, St 707 getter powder can be partially sintered with fine zirconium powder to form a porous body. SAES Getters' St 172 porous getter is manufactured particularly for low working temperatures (around room temperature).

St 707 Getter Types

St 707/Pill/A-B/C

This getter type consists of St 707 getter powder compressed in the form of a pill. The letter **A** indicates the diameter of the pill, **B** indicates the height and **C** the exposed geometric surface area.

The following types are available.



	A Dia. (mm)	B Height (mm)	C Geometric surface (mm ²)	Alloy weight (mg)
St707 Pill/4-2/50	4	2	50	130
St707 Pill/6-2/100	6	2	100	275
St707 Pill/6-4/130	6	4	130	550
St707 Pill/10-3/250	10	3	250	1200

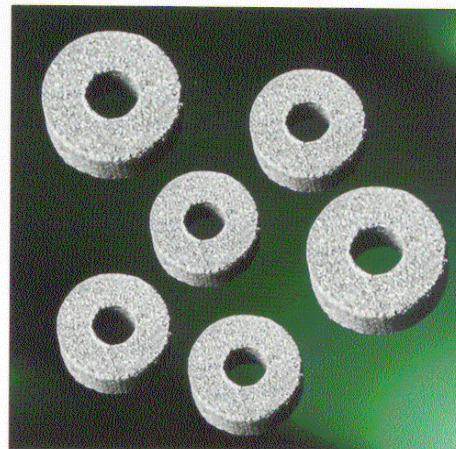
Other models may be available on request.

St 707 Washer 833

This is a variation of the pill type with a hole in the center to allow its mounting on a suitable support.

The characteristics of the St 707 washer are:

- External diameter (mm) : 8
- Internal diameter (mm) : 3
- Height (mm) : 3
- Geometric surface area (mm²) : 190
- St 707 alloy weight (mg) : 600



St 707 Strip

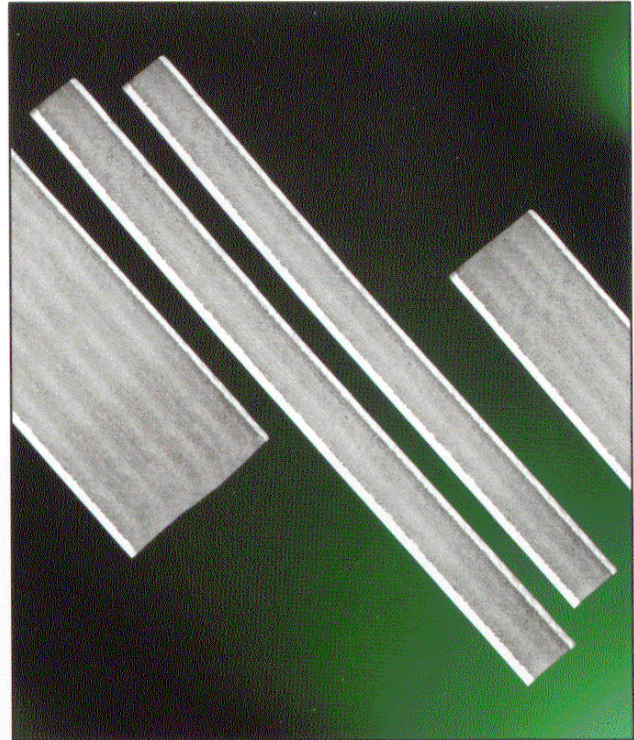
This getter type consists of St 707 powder deposited and fixed on both sides of a thin continuous metallic strip.

The powder is firmly attached to the strip by compression bonding without using any type of chemical binder.

The thickness of the St 707 getter layer is about 70 micrometers on each side of the strip. The powder retains a relatively high degree of porosity (giving a surface area of about 1500 cm²/g) to ensure high gettering performance.

The continuous St 707 strip may be cut by the user to different lengths and suitably bent, according to the type of application.

Activation by passage of current through the strip is possible.



Type	Base material	Width of the strip (mm)	Approximate weight getter material (g/m)	Max tolerable temperature under vacuum (°C)
St 707/CTAM/30D	Constantan (55%Cu-45%Ni amagnetic)	30	20	700
St 707/CTS/NI/8D	Nickel pleated iron (magnetic)	8	3,6	900

Some practical hints on the use of St 707 getters

Storage. St 707 getters are packed in sealed cans under a protective argon atmosphere. This method of packing allows practically indefinite storage. Once the original packing is opened, it is recommended that extended exposure to air be avoided to prevent contamination by foreign particles and moisture. Caution must also be used to prevent spontaneous combustion of the St 707 fine powder. Handling the powder under inert gas, such as argon, is therefore recommended. **If the alloy does ignite, the combustion, not violent, can be extinguished by pouring sand on the burning material.** Water must be avoided. Prolonged storage of getters after opening the original package should always be under vacuum or in a dry environment.

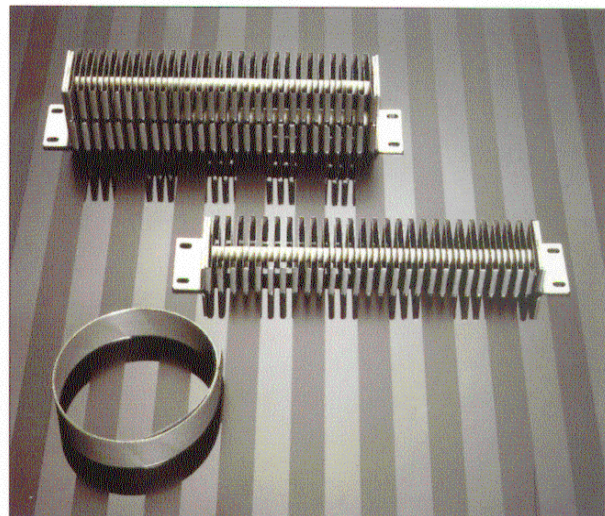
Handling. St 707 getters may be handled in the atmosphere before mounting within the device. To prevent contamination, the use of plastic or rubber finger cots is suggested. Cotton or synthetic fibre gloves should be avoided.

Sealing. During the sealing or assembling operation, it is necessary to minimize the risk of getter deterioration. Overheating the St 707 alloy in air and/or in forming gas must be avoided. Exposure to air in excess of 200°C will cause the getter material to burn.

The St 707 alloy is also used in SAES Getters SORB-AC® Pumps and Wafer Modules



SORB-AC Pumps



Wafer Modules

See the specific catalogues