



## SiFusion® Silicon Components

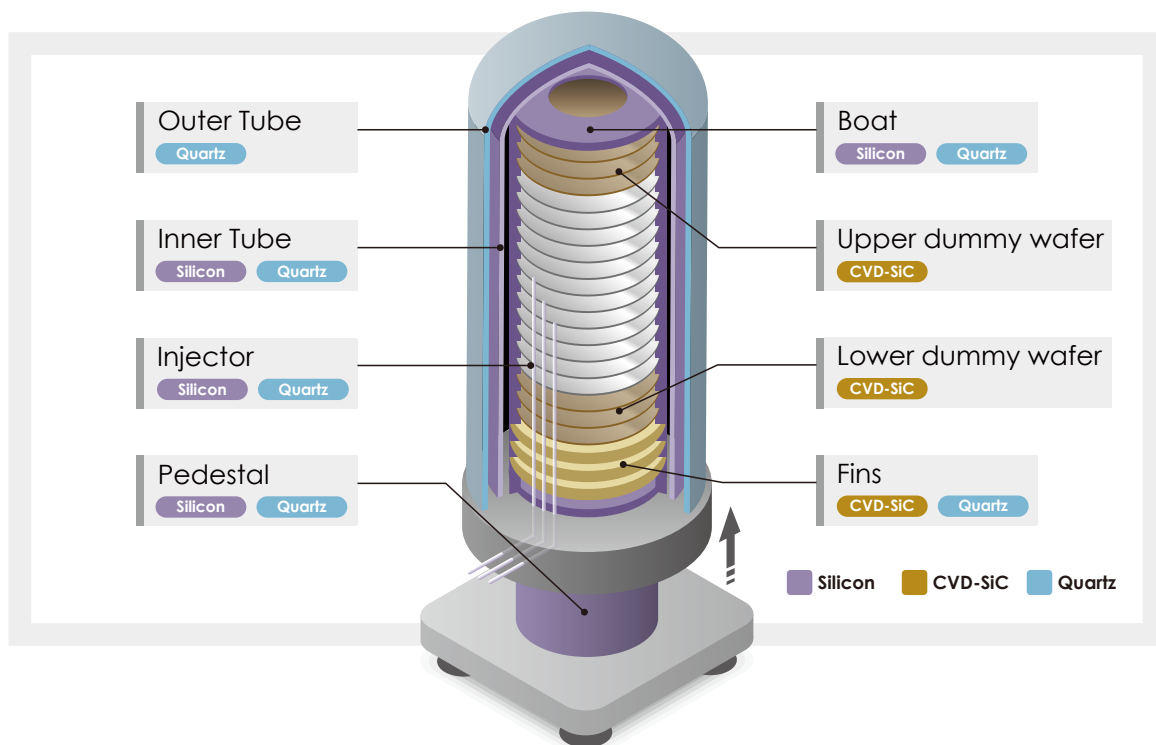


## Today's challenge in FEOL wafer processing

Fabs and foundries continue to push the limits of physics by shrinking the line widths of miniscule circuits with advanced technology nodes. Along with the gains comes the difficulty to keep up with more stringent restrictions on contaminants, particles, boat marks or slip lines generated during wafer processing.

Front end thermal processing tools are equipped with high purity components within the wafer process area, such as boats (carriers, towers) to hold or carry the wafers, injectors to transport process gases, and other various components depending on the tool configuration. Horizontal furnaces have a paddle or cantilever to support the boat while vertical furnaces often have a pedestal or baffle holder to both support the wafer boat and in some cases hold baffles that provide thermal uniformity in the chamber.

### Example of Ferrotec Silicon, CVD-SiC and Quartz Products in a Vertical Furnace



Choosing the best materials for the job can impact total cost and identify potential for savings. It is important to understand material options, and make the right choices to provide the best value for Fab operations.

This Paper explains the value of using batch furnace components made of high purity monocrystalline or polycrystalline silicon – Ferrotec's SiFusion® components and Ferrotec SiParts.

## Materials

Material choices to fabricate furnace components of high purity and strength, which are inert to the process wafers and gases, are limited. Quartz and CVD coated SiSiC are the traditionally used materials, but Silicon is becoming known as the best option improving cost of ownership for high volume manufacturing.

### Quartz

Quartz is the most prevalent and affordable option, but there are limits.

Above 1000°C quartz runs the risk of deforming or warping from thermal stress. The CTE mis-match between quartz and Si wafers often leads to films delaminating even in lower temperature LPCVD processes like poly-Si and SiN. Quartz parts have limited life and need to be replaced often. The acid etching required to remove process films from the quartz parts tend to attack the quartz, making them unusable after few uses.

### CVD Coated SiSiC

CVD coated Silicon Carbide (SiSiC) is the industry standard for high performing spare parts in diffusion furnaces.

The CTE is closer to Silicon than quartz, allowing for some yield improvement in HT and LPCVD poly-Si and SiN applications. CVD coated SiSiC offers a high purity surface to reduce process contaminants. CVD coated SiSiC is also chemically inert and compatible with process gases, and also holds up well over many maintenance cycles to the acid etching required to remove process films, significantly improving its lifetime over quartz.

However, it is important to have the CVD coating intact as metallic impurities in the SiC bulk substrate can have significant impact on the impurity levels of processed wafers. Mechanical chipping of the CVD coating is a known threat to users, which not only causes increased impurity levels, but also weakens the stability of the product itself. When using CVD coated SiSiC, fabs need to be cautious not to run parts with a compromised CVD coating.

Any chippings, small cracks or breakages are non-repairable, hence CVD coated SiSiC components are often scrapped once a damage on the part itself or on the CVD coating is detected.

With only very few suppliers to fulfill the global demand, it is no wonder that waiting partly 2+ years for some CVD coated SiSiC parts has caused severe supply issues in the marketplace.

## You want to improve your device yield ? - Use Ferrotec 's SiFusion® Silicon Parts

Ferrotec Silicon parts are 99.9999% pure Si, with no additional impurity sources. Ferrotec Silicon parts have long been used in single wafer etch and epi tools, and components for batch thermal processing made of high purity silicon are now also available.

Silicon is the material of choice, providing the highest performance and lowest cost of ownership for thermal processing components in many applications.

Some Wafer Fabs have been using Ferrotec Silicon components for 10+ years and are enjoying the many inherent benefits of using SiFusion® parts.

First and foremost, the CTE is an exact match to Silicon wafers. With perfect CTE matching, backside scratching and slip lines associated with CVD coated SiSiC are virtually eliminated when upgrading to long tooth Silicon boats for High Temperature processes. Using Silicon boats has many performance advantages compared to CVD coated SiSiC, in that it directly translates to improved device yield across a wafer.

### *Demonstrated 300mm Customer Performance Data*

- 50% reduction in critical pattern shift (TTX)
- 20% reduction in contact point damage (TTX)
- 30% reduction in contact point stress (SIRD)

### **4-6 % device yield increase**

Operating Temperature: 1250°C

CTE: 3.8 E-06/K (same as Si Wafer)

Trace metal concentration: 1 E10 atoms/cm<sup>2</sup> or better

Bulk Material Purity: 99.9999999999 Si

In case of CVD coated SiSiC, compromised CVD coatings can be a source for outgassing and outdiffusion of impurities from the bulk SiC. Using pure silicon boats, this risk is eliminated, even in case of small surface damages on the silicon part.

Not only Silicon boats will improve your process performance. For example Silicon injectors can also do this. Many Fabs utilize quartz injectors for tools running LPCVD poly-Si deposition. Quartz injectors are very inexpensive and easy to categorize as disposable after only 10-15 um of poly-Si film deposition. CTE mis-match can lead to stress and plugs of poly-Si becoming dislodged from the quartz injector, leading to particle bursts that shorten process runs - leaving deposition levels short of process goals. Another shortcoming is that brittle quartz often breaks when technicians attempt removal. Besides a risk for health and safety of technicians, this leads to challenging and time consuming cleanup within the chamber, forcing additional downtime. This can be solved with Silicon injectors that can run to 120-240 um poly-Si deposition before replacement is required. The purchasing price is higher than quartz, but the benefits far outweigh the cost difference. Moving to Silicon injectors for LPCVD poly process is a most beneficial upgrade.

## **You are suffering from long SiSiC lead times ? - Ferrotec´s SiFusion® Silicon Parts will help you out**

Now is the time to upgrade to Silicon. Ferrotec can supply some parts in as little as 6 weeks, with standard lead times for most parts in the 8-14 week range. Capacity expansion is now ongoing to meet the rapidly growing demand in the global market.

Ferrotec offers to have damaged silicon boats repaired. This can be another aspect for improved cost-of-ownership compared to CVD Coated SiSiC.

Ferrotec is available to support qualifications of parts and conversions to Silicon from other materials, to boost process performance in order to meet current and future performance expectations in semiconductor manufacturing.

### About Ferrotec:

Ferrotec is a dynamic supplier with the most comprehensive array of product solutions and supply capability in the semiconductor market. Ferrotec is OEM certified for many parts and offers solutions covering:

- **SiFusion Silicon Components**
- **Fabricated Quartz**
- **CVD-SiC**
- **Silicon Wafers**
- **Quartz Crucibles**
- **Ceramics**
- **DBC / AMB**
- **Thermoelectric Solutions**
- **Vacuum Feedthroughs**
- **Contract Manufacturing**

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