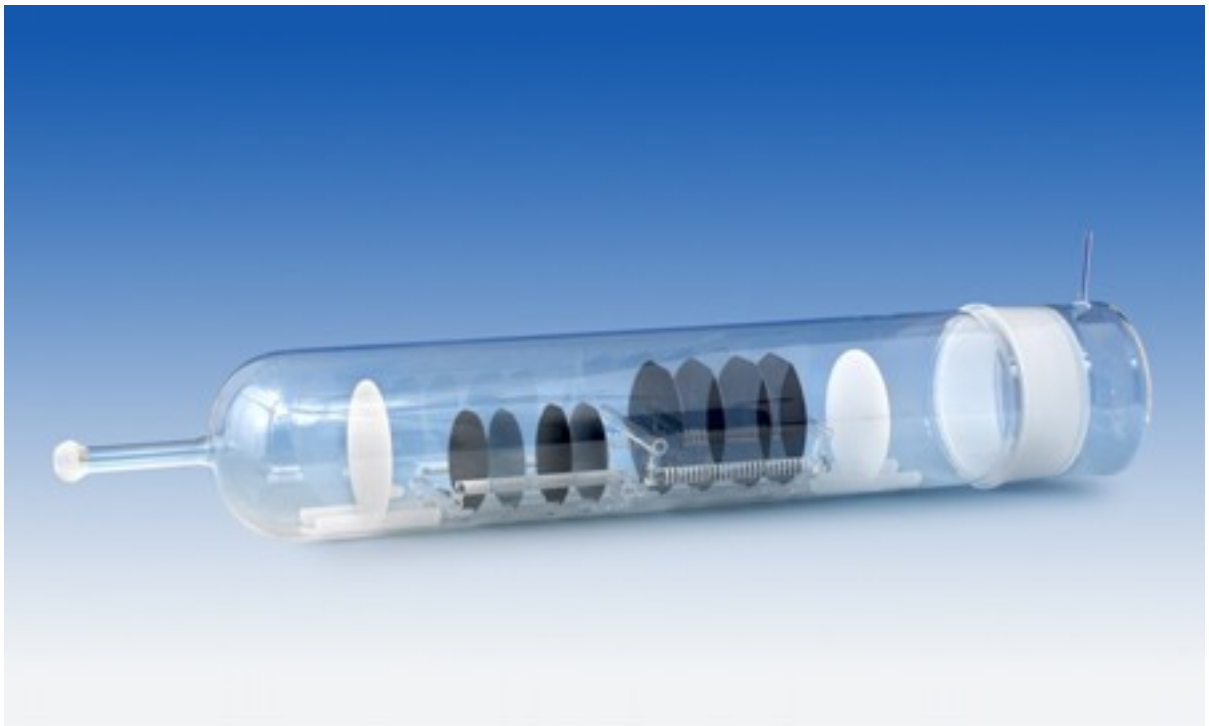
Avoiding Semiconductor Failures - The Expanding Role of Quartz

Jim Horvath, President, Technical Glass

Although world demand for semiconductors is expected to continue its rebound in the near future, whether up or down, the industry will always be among the most uniquely demanding and competitive. Among the factors affecting fabricators' abilities to compete in this volatile market are continuous increases is product performance as well as increased manufacturing productivity.



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While the range of semiconductor-dependent devices continues to widen, industry studies show that sizable semiconductor failure rates (often depending on application complexity), can quickly blunt a fabricator's competitive edge.

Some of the avoidable stress factors effecting semiconductor reliability include process impurities, wafer sag (deformation), and high temperature failures (aside from more obvious mechanical and environmental problems). The avoidance of these problems have led many fabricators to choose fused quartz as the material of choice for semiconductor wafer processing as well as laboratory and testing applications.

Physical properties such as hardness, chemical purity, resistance to high temperatures and corrosion, and electrical insulation make structures composed of fused quartz ideal for various industries. These include various semiconductor applications as well as fiber optic and photovoltaic (solar) cell manufacturing, and laboratory ware.

“Fused quartz is one of the purest materials available, having a nominal purity of up to 99.996 percent,” explains James Horvath, President of Technical Glass Products (TGP), Painesville, OH, one of the nation’s largest distributors and fabricators of fused quartz material. “The purity of quartz is highly beneficial to semiconductor fabricators, since even trace amounts of impurities will be transported to silicon wafers and wreak havoc on performance, often making them unacceptable. For example, the presence of any number of impurities can alter the performance of dopants (e.g. phosphorous or arsenic), creating the occasion for lag, thereby interfering with semiconductor performance. Even trace amounts of alkali can reduce wafer yields.”

Horvath says that the exceptional purity of quartz is unsurpassed in the glass industry, and are much superior to borosilicate products. He adds that the optical purity of quartz that may be equally important to many users in laboratory environments because a relatively broad range of light wavelengths to pass unimpeded through clear quartz ware, which is vital to many laboratory applications.

Another important property of quartz that relates directly to wafer processing is that its mechanical stability provides the ability of the material to withstand high temperatures. Fused quartz products can be heated to 1150 degrees C (under minimal load conditions), making quartz tubing an excellent furnace chamber for processing silicon wafers. This is significant in silicon wafer production because sag is virtually eliminated, and a longer furnace lifespan is assured. For superior performance at higher temperatures, Type 214 LDH furnace tubing gives process engineers a better balance between the effects of higher temperatures and heavier wafer loads.

Leading suppliers offer a broad range of products that are used in semiconductor fabrication. For example, Technical Glass offers an exceptional line of raw material and semiconductor fabrication ware, including plasma chambers, epitaxial systems, bell jars, tubing up to 400 mm, and many other items.

Fused quartz stock is available in a variety of standards that provide different properties to industry engineers. The following are examples supplied and manufactured by Momentive Performance Materials, a world leader in manufacturing of high-purity fused quartz products:

• Type 214 clear quartz tubing and rod offers minimal air lines and inclusions, and are often chosen for wafer production due to excellent dimensional stability.

• Type 214 LD [large diameter] clear fused quartz tubing offers the same excellent properties as Type 214, but is used for diffusion, oxidation and LPCVD (low-pressure

chemical vapor deposition) processing.

• Type 124 fused quartz offers high purity but contains some fine bubbles. Available in a variety of shapes and sizes, it is an economical product used to fabricate wafer carriers.

• Type 012 Ingots - Clear synthetic fused silica ingots in the same form as 124. Its ultra high purity makes it useful for plates and discs used in the most critical semiconductor processes.

“In many instances, in addition to product selection, semiconductor industry customers should also consider what technical services are needed,” Horvath advises. “Highly experienced quartz glass blowers should offer a full range of ancillary services, including assistance with product design, applications and specifications, fabrication services, machining and assembly, and repair.”

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