Quartz Annealing Oven Basics

By Steve Mortensen

The quartz annealing industry has traditionally used very simple annealing equipment which in many cases was not thoroughly engineered. Such ovens generally did an acceptable job of annealing quartz, but not without cleanliness and maintenance problems which added unnecessary cost and production time.

As quartz applications have grown in recent years, quality requirements and other competitive forces have likewise increased. In order to be competitive today, quartz manufacturers must ensure that their annealing equipment easily meets cleanliness requirements, has the lowest practical energy and maintenance costs, and can anneal product in the fastest possible time to maximize equipment productivity.

This discussion focuses on two of the basic issues that affect cleanliness and maintenance costs - the heating system and the insulation. If these issues are correctly addressed in the annealing oven design and construction, then product contamination and maintenance problems can be eliminated or minimized.

The most common problems with quartz annealing ovens have typically been:

1. Dirty heating systems that contaminate the product being annealed
2. Poorly designed heating systems that require too much maintenance and are difficult to work with
3. Wattage loading of the heating element design is incorrect which causes premature element failure and results in higher maintenance costs
4. Poorly maintained brick insulation that takes too long to heat and cool and may also contribute to product contamination problems
5. Poorly designed and constructed fiber insulation systems that require too much maintenance and are difficult to work with

Dirty Heating Systems

Wire wound heating elements are the number one cause of contamination in quartz annealing ovens. The most commonly used iron-chromium-aluminum alloy element wire oxidizes at high temperature, and expansion and contraction of the coiled wire causes small oxidized particles to be ejected into the workspace - and onto the exposed product surfaces.
There are two other choices for heating elements at quartz annealing temperatures - silicon carbide and molybdenum disilicide. Both of these element types are well suited for quartz annealing in terms of temperature and cleanliness. There are conflicting opinions about the best element choice for the application, and there is no conclusive evidence that one element is better or cleaner than the other. Leading quartz manufacturers who use both types of elements in various oven designs have demonstrated that both types are well suited to meeting cleanliness requirements.

**Poorly Designed Heating Systems**

Wire wound elements have been mounted into ovens in many ways - in grooves cut into the insulation, held to the wall by wire pins, in ceramic plates or vacuum cast fiber panels, etc. Some mounting techniques are better than others, but they all require access into the heating chamber for replacement. During element replacement, damage to the insulation system may occur which will increase the maintenance cost of the oven.

Silicon carbide elements and molybdenum disilicide elements mounted through the roof do not require access into the heating chamber in order to change an element. Heating elements can be removed and replaced from the oven exterior. Either element type is much easier to replace than wire elements, and the potential for damaging the insulation is greatly decreased.

**High Wattage Loading**

The main problem with watt loading is once again with the wire wound elements. In order to provide faster heating (in theory), wire elements have been built into many ovens that have watt loading that exceeds the recommended limit. This causes the elements to burn up rather quickly, exacerbating the problems of contamination, high maintenance cost, and potential insulation damage during element replacement.

Molybdenum disilicide elements have the highest watt loading capability of the three element types discussed, with silicon carbide elements having the second highest. Wire wound elements have the lowest watt loading capability.

Higher watt loading capability means that the elements provide more heating power per square inch of element surface area. Therefore, molybdenum disilicide elements can provide the fastest possible heating rates, with silicon carbide elements being a close second. Wire elements are not well suited for fast heating because of their low watt loading capability. When a wire element is designed with a high watt loading, it will burn up in a short period of time.