Gallagher Fluid Seals recently added a new white paper to its Resources Page, Perfluoroelastomers for the Semiconductor Industry, written by Russ Schnell. Below is an excerpt from the new white paper discussing thermal process manufacturing. You can download the white paper in its entirety by clicking on the thumbnail to the right.

The term “thermal process” covers a fairly wide range of applications. Per the name, these application temperatures are generally higher than plasma processes, ranging up to 300°C. This general term can cover processes including: Sub Atmospheric Chemical Vapor Deposition (SACVD), Metal CVD, Low Pressure CVD (LPCVD), Rapid Thermal Processing (RTP), and Oxidation or Diffusion furnaces. In these applications the wafers and the equipment that surrounds them, are heated to extremely high temperatures. In the case of thermal deposition, the high temperatures aid in the uniformity of the coating thickness.

Rapid Thermal Processing is used to very rapidly heat a wafer up to temperatures of 1000°C or greater for short periods of time. “Rapid Thermal Processing (RTP) can be used to reduce the thermal redistribution of impurities at high temperature.... RTP was originally developed for ion implant anneal, but has broadened its application to oxide growth, chemical vapor deposition, and silicidation.” For oxidation or diffusion furnaces, the applications are
different, but still involve high temperatures. For oxidation applications, the procedure involves formation of a thin oxide film on the wafer surface. For diffusion applications, the furnace may assist in silicon dioxide formation on the wafer surface or it may be used to diffuse dopants in the wafer. For these applications, temperatures may range up to 1200°C.

**Perfluoroelastomer Seal Requirements in Thermal Processes**

For these processes, the main factor in elastomer selection is high temperature performance. Many of these applications use elastomers which are filled with standard fillers such as carbon black. These elastomers are not subjected to aggressive etching requirements as in plasma processes. Primarily the elastomer must survive high temperatures and be able to maintain sealing force after exposure to high temperature cycling, which is extremely hard on elastomers and hastens loss of sealing force. Carbon black fillers provide the best resistance to compression set (loss of sealing force) for carbon backbone elastomers.

Another primary consideration is minimal outgassing at high temperatures in order to avoid contamination of the wafer surface. Perfluoroelastomers provide the lowest outgassing at high temperatures. The high application temperatures may be achieved by various methods, for example, high temperature lamps. Specific FFKM products are available and should be selected for the best performance in these types of applications.

**Thermal Process Applications**

Some of the applications are similar to those listed for plasma processes, except that thermal processes usually have higher application temperatures. For these applications, proper elastomer groove design becomes even more critical. High service temperatures result in large thermal expansion for perfluoroelastomers. The volume of the groove design
must be sufficient to accommodate this thermal expansion or the FFKM seals will overfill the groove, extrude and subsequently fail in service.

**Quartz Chambers**

These chambers may be used as the “hot” section of the furnace. Quartz can withstand very high temperatures without yielding contaminants that could cause problems with the wafer being treated. Elastomer seals for these applications are exposed to very high temperatures and shielding is often needed, or at least helpful, to reduce direct exposure of the elastomers to the high temperatures. Shielding is even beneficial for perfluoroelastomer seals to improve service life. For lamp anneal processes, non-black elastomers are often used because they reduce the absorption of heat from the lamp source, increasing elastomer service life.

**Plenum Seals**

Plenums provide space for equipment such as cables and chambers. These seals are also exposed to extremely high temperatures. As mentioned previously, elastomer seals must resist degradation at high temperatures and perfluoroelastomers are the seal of choice. Proper groove design is critical for these services to avoid elastomer extrusion. Any methods for cooling and reducing the temperature at the seal location will help prolong seal life.

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**About the Author**

Russell Schnell spent more than 37 years as an engineer with DuPont, the last 26 years as a Senior Application Engineer with the Kalrez® perfluoroelastomer parts business. Recognized for his expertise in elastomer applications, seal design and failure analysis, he provided technical support for a wide range of industries including: chemical processing, aerospace, oil and gas, pharmaceutical and semi-con. He created and conducted hundreds of training seminars and workshops in this field and was solely responsible for the development of the Kalrez® Application Guide software tool.

Russ received a Bachelor of Science in Chemical Engineering from Columbia University in New York and MBA from the University of Delaware.