Thermal Resistance and Sealing Applications in the Semiconductor Manufacturing Industry - Part 1

Figure 1 Vulcanization: Cross-linking elastomers to give unique properties

Elastomers are made of long random chains of oriented molecules that are subject to entanglement and cross-linking which give the elastomer viscoelastic properties that are key for sealing performance. Viscoelastic properties (which can be thought of as energy stored or energy dissipated) are needed in sealing elastomers. In addition, curatives are added to the elastomer which provide sealing resiliency.

FFKM's (PERFREZ®) are terpolymers that are more linear chains that offer the highest chemical resistance (will be addressed in future articles) and the highest maximum temperature in elastomers (with peroxide cure compounds reaching a maximum of 280°C and triazine cure materials that suggest a maximum temperature of 320°C). However, these temperatures are not operating temperatures and can be deceiving as standard elastomers often deteriorate at elevated temperatures and the thermal exposure affect the volume change of the compound. Application temperatures need to be accommodated for in seal design.

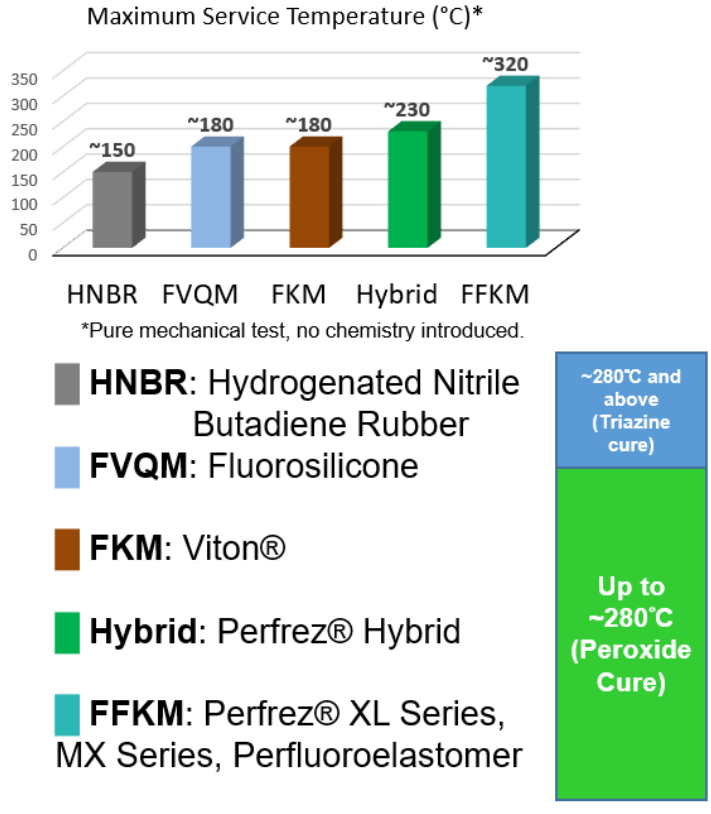

Figure 2 Temperature consideration for various elastomer families

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The Coefficient of Thermal Expansion (CTE) plays an important role in seal performance. The CTE describes how the size of the elastomer changes in temperature. Engineered seal designs should take into consideration the install and operating and maximum service temperatures the seal is exposed to. Taking a standard AS-214 seal shown in Figure 3, exhibits how temperature can change the sealing length in a seal.

	PERFREZ® 5033 CTE: 2.31 E-4 / °C	PERFREZ® XL12 CTE: 2.61 E-4 / °C	Competitor K CTE: 4.64 E-4 / °C	Competitor P CTE: 5.20 E-4 / °C
150°C	+Δ78.39 mm³	+Δ88.57 mm³	+Δ157.46 mm³	+Δ176.46 mm³
200°C	+Δ108.77 mm³	+Δ122.90 mm³	+Δ218.49 mm³	+Δ244.86 mm³
250°C	+Δ139.16 mm³	+Δ157.23 mm³	+Δ279.52 mm³	+Δ313.26 mm³

Volumetric expansion calculation using AS-214 O-ring as an example (ID 24.99 mm x CSD 3.53 mm, Seal Volume 876.88 mm³) and assuming ambient temperature of 21°C

Figure 3 CTE significance example

This can affect the volume fill, which can lead to extrusion, excessive stress on the elastomer, added contaminants, loss in sealing performance and a reduction in yield.

Thermal aspects play a crucial role in sealing performance. ASNA has created a tool that reviews design parameters and PERFREZ® elastomer selection through our web-based engineering design calculator referred to as ACE®. Explore our product selection and information at *www.asnaglobal.com*

ACE® ASNA Calculated Engineering

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