



# DuPont™ Kalrez®

PERFLUOROELASTOMER PARTS

RELIABLE, LONG-TERM SEALING IN EXTREME  
CHEMICAL AND THERMAL ENVIRONMENTS



*The miracles of science™*

## You Can Rely on DuPont™ Kalrez® Sealing Solutions in the Harshest Processing Environments

### Engineered for optimum performance

For over 40 years, DuPont has been relentless in pursuing improvement in the manufacture of perfluoroelastomer parts. Elastomeric parts typically consist of three components: a polymer chain (the backbone of the elastomer), a crosslinking system (which links the polymer chains together and is the key to elasticity and sealing performance), and a filler system (used to enhance mechanical properties). Based on our extensive experience, DuPont adjusts these components to optimize seal performance.

### Reduce maintenance costs

DuPont™ Kalrez® parts help stretch your mean time between repair (MTBR) and lower your maintenance costs. Their durability minimizes unscheduled downtime while letting you extend time between routine inspections and replacement cycles for critical components.

### Increase productivity

By reducing the frequency of seal changes, repairs and inspections, you can increase process and equipment uptime for greater productivity and yield.

### Increase safety

Lasting longer and performing better than other elastomers, Kalrez® helps reduce the risk of chemical exposure from seal failure.

### Reduce fugitive emissions

Kalrez® and Kalrez® Valve Stem Packing Systems can help you reduce leaks and fugitive emissions for improved compliance with environmental regulations. Because Kalrez® parts maintain their sealing integrity, you reduce your risk of environmental non-conformance.

### Maintain process purity

Kalrez® parts help prevent process contamination by:

- Resisting degradation in harsh chemicals
- Maintaining sealing force at high temperatures to reduce leakage
- Containing fewer ingredients that extract into the process
- Providing lower outgassing in vacuum sealing
- Meeting stringent FDA regulations for purity and cleanliness

### ISO 9001 quality assured with full traceability

Kalrez® parts are made only by DuPont, a fully integrated manufacturer of Vespel® parts and shapes, Viton® fluoroelastomers and Neoprene rubber polymers, as well as perfluoroelastomer parts. Kalrez® parts are manufactured in ISO 9001 quality certified facilities and packaged in a bar-coded bag for full traceability.



## DuPont™ Kalrez® Offers a Variety of Products to Meet Your Application Needs

The DuPont™ Kalrez® product line has been specifically designed to deliver outstanding performance in aggressive process environments. Whether it's resistance to acids, amines, ultrapure de-ionized water, strong bases or high temperatures, by selecting the Kalrez® part that is best suited to a specific application, manufacturers can improve seal performance in their operating environment.

### **Broad chemical and temperature resistance in chemical/hydrocarbon processing**

Processing environments in chemical and hydrocarbon plants are running hotter, longer and with more aggressive chemicals. In order to increase meantime between repair (MTBR) and improve safety, Kalrez® has been the product of choice. The industry standard has long been DuPont™ Kalrez® 4079, but increasing demands on production have called for new products with even greater performance capabilities. Today, the DuPont™ Kalrez® Spectrum™ family of products expands on the chemical and thermal properties of Kalrez® 4079 to better meet the requirements of these applications.

### **Purity in food and pharmaceuticals**

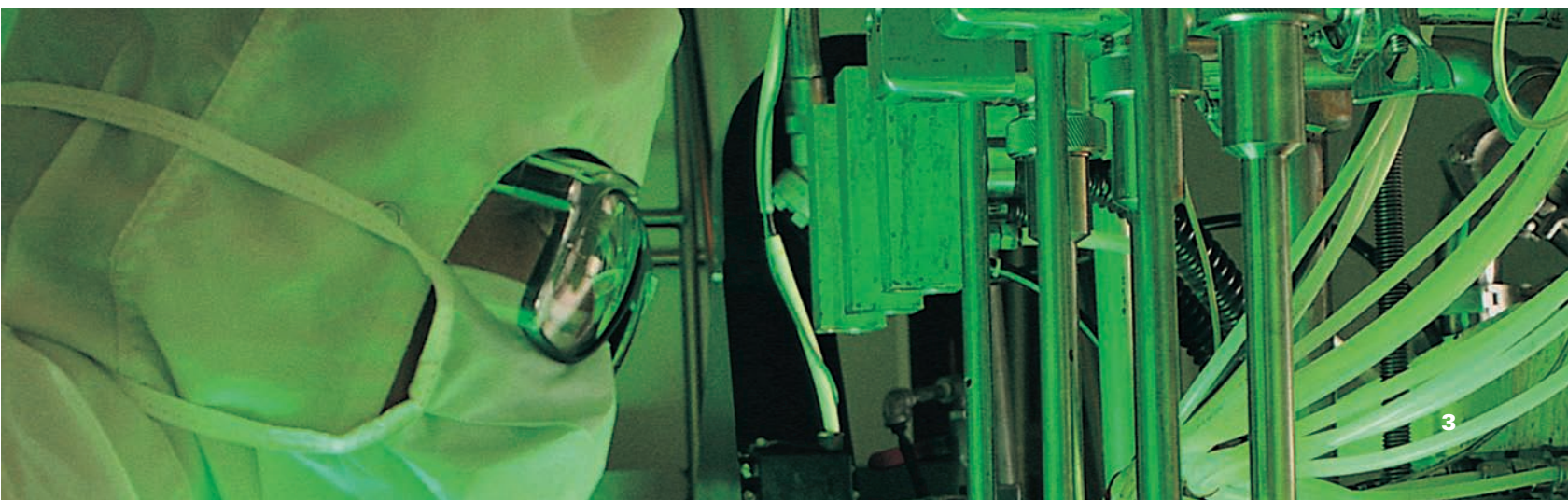
The regulatory requirements of the food and pharmaceuticals industries require increased awareness and stricter guidelines regarding product safety. Kalrez® parts for pharmaceutical applications offer cleanliness and chemical inertness with the resilience of a true elastomer. With its combination of thermal and chemical performance and rubber-like sealing ability, Kalrez® offers the pharmaceutical industry a new level of protection against contamination and seal failure.

### **Electronics**

Kalrez® parts help reduce the total operating cost of wafer processing, photovoltaic manufacturing processes, and flat panel display equipment by providing longer seal life and increasing meantime between repair. Unplanned maintenance due to incompatible sealing materials can interfere with production schedules, causing downtime. Kalrez® parts can help improve sealing reliability in processes that use high heat, aggressive chemicals and plasma.

### **Other demanding applications**

Because of its exceptional chemical and temperature resistance, Kalrez® was first used in aerospace and downhole applications. Its outstanding resistance to fuels, additives, lubricating oils and corrosive chemicals has made Kalrez® the product of choice in the most aggressive environments where seal failure is unacceptable.





# DuPont™ Kalrez® Delivers the Broadest Chemical Resistance Across the Board

## Superior chemical resistance to more than 1800 chemicals

DuPont™ Kalrez® perfluoroelastomer parts have virtually universal chemical resistance. They withstand attack from more than 1,800 chemicals, solvents and plasmas. Standardizing on Kalrez® products for broad chemical resistance reduces your need to keep multiple materials on the shelf, thus lowering cost of inventory.

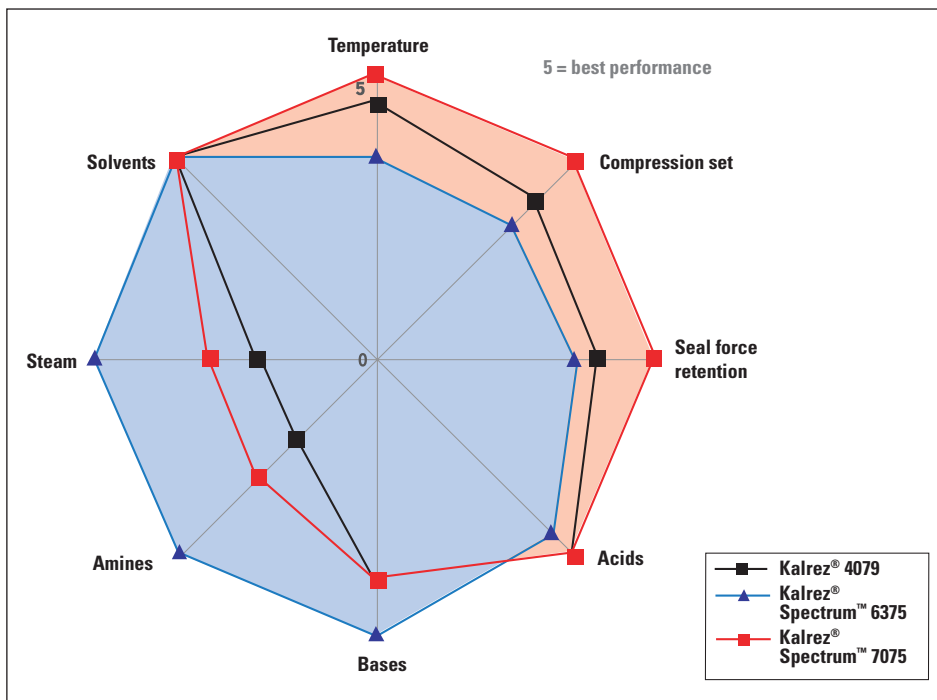
## Minimal swell

Chemically induced swelling can cause O-rings and sealing components made of other rubbers to expand out of retaining grooves, resulting in seal failures. Kalrez® parts resist extreme volume swell when exposed to a wide variety of chemicals and solvents, including concentrated nitric acid, sodium hydroxide, ethylene diamine and steam.

## Optimizing chemical resistance and seal performance

In order to maximize seal performance in specific applications, DuPont continually develops new products as emerging needs are discovered. In chemical and hydrocarbon processing, a family of products called DuPont™ Kalrez® Spectrum™ are available for better overall chemical resistance and higher thermal stability. This combination gives processors a larger operating window for additional chemical usage and higher temperature excursions. For more specific information about the chemical compatibility of Kalrez® parts, consult the DuPont Chemical Resistance Guide or the Kalrez® Application Guide available on our website or contact your Kalrez® parts authorized distributor.

## Advancements in polymer technology have improved chemical resistance of elastomers



# DuPont™ Kalrez® Performs in High Temperature Applications and Processes

## Service temperature range up to 327 °C

Even after long-term exposure to temperatures up to 327 °C (620 °F), DuPont™ Kalrez® parts retain their elasticity and recovery properties better than other high-temperature elastomers. Their high-temperature properties, coupled with near universal chemical resistance, enable Kalrez® parts to withstand an extremely broad range of process media.

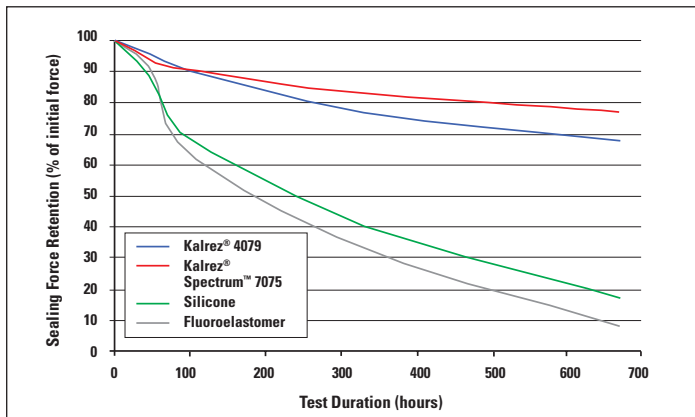
## Maintains sealing force to keep seals tight

As proven in ISO 3384 tests, Kalrez® parts outperform other elastomers when it comes to sealing force retention, a measure of seal life. Even under harsh and aggressive conditions, Kalrez® will retain its sealing force longer. And thanks to its true-rubber resiliency, Kalrez® prevents leaks caused by creep, a major problem with PTFE.

## Low compression set

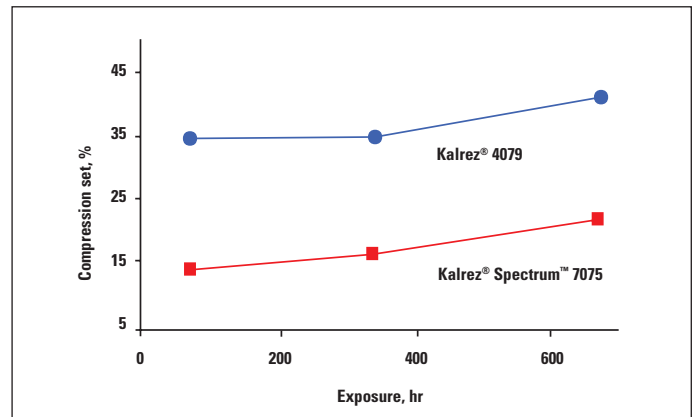
Kalrez® parts exhibit low compression set, maintaining their elastic recovery to maintain tight seals over the long haul. Because Kalrez® parts recover better under compression than other perfluoroelastomer parts, they maintain their shape better under prolonged stress.

### Sealing force retention at 204 °C



Test method: ISO 3384: 1991, method A, 214 O-ring

### Compression set at 204 °C

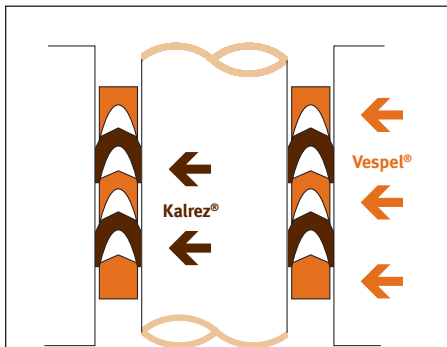


Test method: D395B, 214 O-ring



## DuPont™ Kalrez® Increases Mean Time Between Repairs in Tough Chemical and Hydrocarbon Processes

### DuPont™ Kalrez® KVSP™ reduces fugitive emissions and improves process control



- Tested up to class 600 per ANSI/FCI 91-1-1994
- Certified according to TA Luft requirements
- Meets requirements of Pressure Equipment Directive PED97/23/EC

### Kalrez® provides long seal life in chemical and hydrocarbon processing

In pumps, valves, mechanical seals or analytical equipment, DuPont™ Kalrez® perfluoroelastomer parts are proving their value year in and year out. Their long-term resistance to the harshest chemicals and the highest temperatures makes them resistant to swelling and embrittlement, a leading cause of premature seal failure. Whether it's O-rings, custom shapes or valve stem packing, Kalrez® parts can improve your productivity, control fugitive emissions and reduce costly seal failures.

### Kalrez® KVSP™ valve stem packing system reduces friction

In either manual or automatic controls, you can improve valve performance, reduce maintenance costs and limit fugitive emissions to less than 10 ppm with DuPont™ Kalrez® KVSP™. Kalrez® KVSP™ is a combination of Kalrez® V-rings and DuPont™ Vespel® backup components that can handle temperatures up to 288 °C. They provide a self-adjusting, maintenance-free alternative to graphite and PTFE (polytetrafluoroethylene) packing systems.

Through reduced friction, Kalrez® KVSP™ improves process control variability, resulting in improvements to both yield and product quality. Friction data proves that Kalrez® KVSP™ performs at levels comparable to PTFE packing sets. No valve modifications are necessary and adjustments are rarely needed after installation to make Kalrez® KVSP™ an important upgrade to valve performance.



## DuPont™ Kalrez® Delivers Integrity and Purity in Pharmaceutical Processes

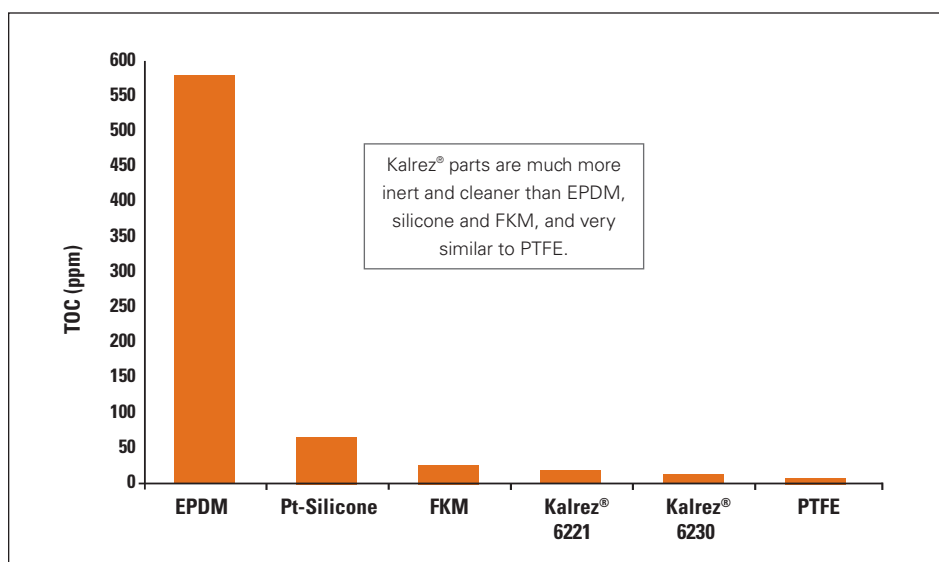
With its combination of thermal and chemical performance, and its rubber-like sealing ability, DuPont™ Kalrez® parts offer the pharmaceutical industry a new level of protection against process contamination and seal failure. Similar to PTFE in cleanliness, heat and chemical resistance, Kalrez® has the resilience and compressive strength of frequently used sealing materials such as ethylene propylene polymers (EPDM), fluoroelastomers (FKM) and silicone rubber. Black and white Kalrez® parts have been developed to meet the unique sealing needs of today's pharmaceutical and biopharmaceutical manufacturing processes for increased purity and sealing integrity.

### FDA and USP compliancy

The U.S. Food and Drug Administration (FDA) confirmed the compliance of DuPont™ Kalrez® 6221 and 6230 perfluoroelastomer parts for repeated use in contact with food by Food Contact Notification (FCN) 000101. FCN 000101 was established through the FDA Premarket Notification Process for food contact substances as described in section 409(h) of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 348(h)) and is the primary method by which the FDA authorizes the use of food additives that are food contact substances. FCN 000101 requires materials to have extractable levels less than 0.2 mg/in<sup>2</sup>. Designated Kalrez® 6221 and 6230 products have been tested in accordance with United States Pharmacopeia Class VI (USP Class VI) and met those requirements. In addition, designated Kalrez® products also comply with the requirements in U.S. FDA regulation 21 CFR 177.2600.

Please see back cover of this brochure for additional information.

### Kalrez® 6221 and 6230 have extractable levels comparable to PTFE



EPA method 415; TOC tests performed on 1" sanitary seals, immersed in 50 mL of sterile WFI at 100 °C/24 hrs. The solution was then diluted to 100 mL and analyzed.



## Deliver Higher Yields in Electronics with DuPont™ Kalrez® Parts

Seals in electronics manufacturing are subject to process conditions that challenge seal performance. Chemical resistance that is nearly universal, coupled with superior high-temperature properties, enables DuPont™ Kalrez® parts to withstand virtually any process media—including plasmas—at elevated temperatures.

In addition to providing superior chemical resistance and thermal stability,

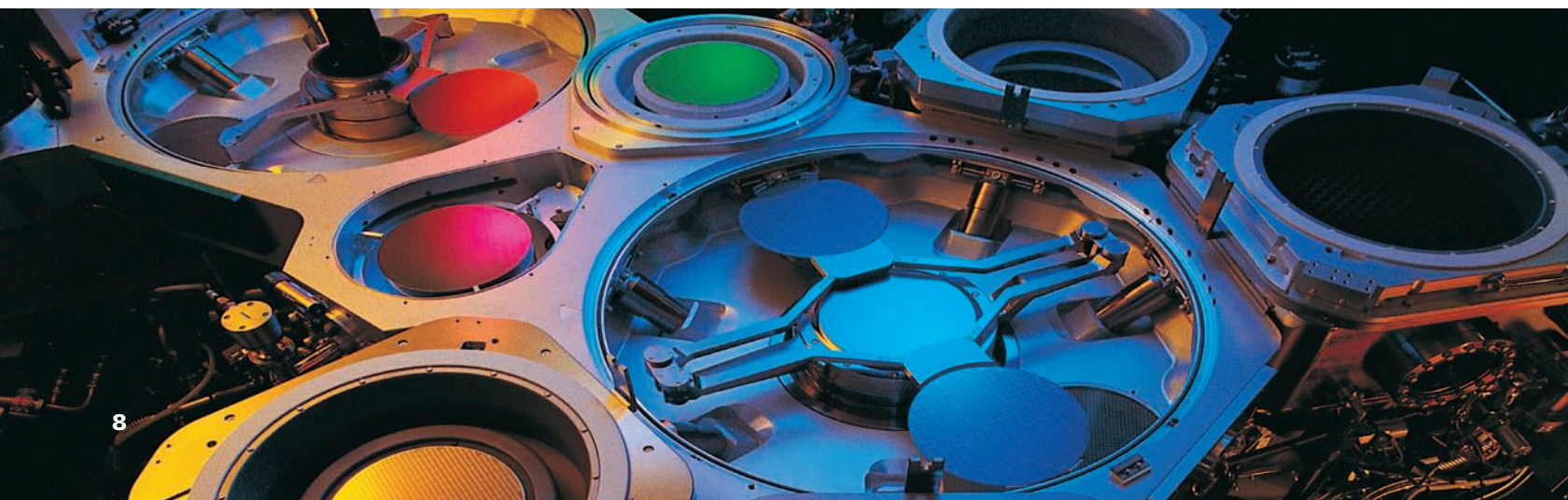
DuPont™ Kalrez® UltraPure™ parts offer lower contamination in reactive plasmas and cleaning gases, improved vacuum-sealing performance and lower outgassing. In addition, Kalrez® UltraPure™ parts are manufactured under clean-cell conditions and specially cleaned and double packaged at Class 100 workstations. Kalrez® provides long-term reliability in aggressive plasmas, deposition, thermal and “wet” processing applications, whether it’s

for wafer processing, photovoltaic manufacturing processes, or flat panel display equipment.

Kalrez® parts are available in standard AS568 O-ring sizes as well as metric and JIS O-ring sizes. Sheet stock and custom geometries are available for die-cut gaskets or custom development.

### Field proven in electronics processes

- Over 50,000 wafers processed in a high-energy oxygen plasma asher without a slit valve seal change
- Over 400 wafer batches (6 months) in a 250 °C nitride LPCVD tube furnace
- 4x improvement in seal life and reduced seal sticking vs. silicone in a 300 °C nitride process
- Doubled seal life in a metal etch process compared to other perfluoroelastomers
- Seal life improved 10x over silicone in a plasma asher door seal at 130 °C
- Lower ionic extractables in a 100 °C wet chemical pump application
- Over 6 months seal life in a large slit valve for Liquid Crystal Display processing etcher
- Over 3 months seal life in a 280 °C diffusion furnace application
- 8 months seal life (35% more than competitive custom slit valve seal) for DuPont™ Kalrez® TriLobe™ in a TEOS PE-CVD process
- Doubled seal life with a Kalrez® seal in a plasma asher
- 8x to 14x improvement in seal life (over 3 months) compared to a competitive perfluoroelastomer in plasma asher showerhead seals
- Doubled seal life compared to a competitive perfluoroelastomer in a PECVD slit valve application
- Best overall performance in LPCVD using  $\text{ClF}_3$  cleaning gas (lower outgassing and particle generation)





# DuPont™ Kalrez® Parts Provide Superior Performance in Other Extreme Environments

## Aircraft and aerospace

The ability to withstand extreme temperatures makes DuPont™ Kalrez® parts ideal for use in aircraft and aerospace applications. Kalrez® parts also withstand aggressive aerospace fluids, including jet fuels, engine lubricating oils, hydraulic fluids, rocket propellants and oxidizers.

Kalrez® has proven its superior performance for more than 40 years in such applications as:

- Aviation, marine and industrial gas turbine engines
- Auxiliary power units
- Hydraulic actuators
- Bleed air valves and fittings

In order to address the industry's need for materials that withstand more aggressive operating environments, the next generation of aircraft/aerospace materials were developed. These products, called DuPont™ Kalrez® AeroSeal™, deliver outstanding thermal stability and compression set resistance, and have excellent seal force retention.



## Oil and gas

Kalrez® parts stand up to severe downhole conditions—from high pressures and temperatures, to aggressive sour gas and corrosive fluids. Blistering heat, corrosive fluids and toxic gases can destroy the physical properties and sealing performance of other materials.

Field-proven across the industry for over 40 years in applications such as:

- Tubing-to-packer seals
- Subsurface safety valves
- Logging boots
- Casing tie-back seals
- Survey tool seals
- Slip-joint seals



# From Technical Assistance to Fast, Reliable Supply You Get More than Just a Product

## Latest updates

We provide our customers with the latest information about sealing performance.

Visit our website

**www.dupontelastomers.com** and read or download the latest product information. Check out the DuPont Chemical Resistance Guide—an online tool that rates the chemical resistance of all elastomers, including DuPont™ Kalrez® and DuPont™ Viton®, in a variety of chemicals.

For more specific information on Kalrez® including seal design, contact us about the Kalrez® Application Guide, a unique interactive software program.

## Worldwide technical support and testing facilities

We help you with the technical assistance and support you might need to achieve optimum results in the shortest possible time. Our worldwide R&D expertise can help you with:

- Compound selection and seal design
- Application testing and development
- Failure analysis
- On-site training

## Fast delivery

Upon agreement and request, standard O-rings and make-to-stock parts can be delivered within 48 hours to most European and North American destinations. Ask our Sales and Customer Service Representatives to find out more.

## In any shape you want

- Standard O-rings in AS-568, metric and JIS sizes
- Customized O-rings in various cross-sections and diameters
- Valve seats, diaphragms, gaskets, packer seals, T-seals, column fittings, custom shapes
- DuPont™ Kalrez® KVSP™ Valve Stem Packing System

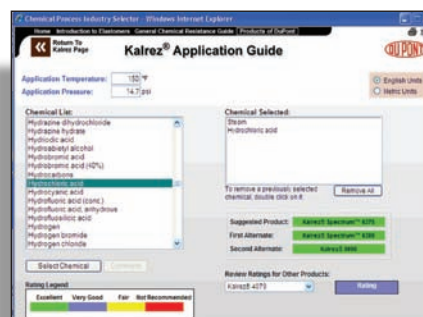
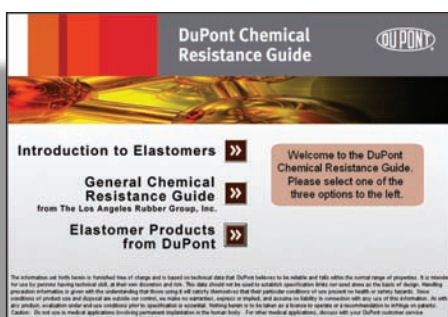
## Customer-tailored solutions—Finite Element Analysis (FEA)

Advanced Finite Element Analysis offers single-source analysis capability. From designing new seal shapes with concurrent analysis to groove geometry optimization, FEA gives unequalled flexibility. It shortens your product development lead times and brings innovative solutions to the market.

## Worldwide presence and network of reliable distributors

Kalrez® parts are readily available through an extensive network of worldwide-authorized distributors. Our authorized distributors can give you the technical assistance needed to help solve your sealing problems. For a complete list of authorized distributors, please contact DuPont.

Visit the DuPont Chemical Resistance Guide at:  
[www.dupontelastomers.com](http://www.dupontelastomers.com)



### Technical support for achieving optimum results

Depend on DuPont elastomers for the support you need to achieve optimum results in the shortest possible time. Our worldwide R&D and application expertise can help you with:

■ Process development

■ Application testing

■ New application development





Visit us at: [kalrez.dupont.com](http://kalrez.dupont.com) or [vespel.dupont.com](http://vespel.dupont.com)

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Contact DuPont at the following regional locations:

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Kalrez® perfluoroelastomer parts are not routinely tested using the USP testing protocol. Cured samples made only from compounds 6221 and 6230 have been tested in accordance with USP protocols and meet the requirements of a USP Class VI polymer. USP testing was done to support use of Kalrez® parts in pharmaceutical processing and food processing applications. While USP Class VI compliance materials are not required for pharmaceutical and food processing applications, many pharmaceutical and food processing customers including customers seeking ISO 9000 certification, have requested compliance. Testing of any finished article that incorporates Kalrez® perfluoroelastomer parts is the responsibility of the manufacturer or seller of the finished article if certification that meets USP standards is required.

Caution: Do not use in medical applications involving permanent implantation in the human body. For other medical applications, discuss with your DuPont customer service representative and read Medical Caution Statement H-50103-3.

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