Technical Information

Semiconductor Wet Processing
Rev. 2, June 2005

Kalrez® perfluoroelastomer parts
From DuPont Performance Elastomers

Kalrez® 6375UP - Optimal Seal Performance and Lower Cost of Ownership

To transform raw semiconducting materials into a useful device requires hundreds of chemical processing steps. A significant number of these steps involve aggressive acids, solvents, and bases (including amines) used to clean, rinse, etch or strip unwanted materials and contaminants from the wafer surface. These chemicals can attack elastomeric seals causing them to swell and degrade or to leach undesirable metallic and ionic extractables that affect integrated circuit functionality.

The trend toward larger wafers, smaller feature size, and decreasing thickness of deposited layers has placed increased emphasis on the need to minimize or eliminate sources of process contamination. Chemical and equipment manufacturers go to great lengths to minimize the potential for contamination that could result in chip defects.

DuPont Performance Elastomers has developed a number of compounds that resist chemical attack and are formulated and processed to minimize the potential for undesirable contaminants. The newest addition to our product line, **Kalrez® 6375UP, has an excellent balance of performance characteristics required for semicon wet processing environments.**

Process Type	Typical Chemicals*	Temp. Range, °C	Kalrez® 6375UP	Kalrez® 4079UP	Kalrez® 1050UP
Wafer Prep, Cleaning, and Rinsing	UPDI, Ozonated DI H_20 TCE, IPA, Acetone Piranha, SC-1, SC-2 HF (49%), O_3	25–125	Suggested Compound	Suitable Alternate	Consult DuPont Performance Elastomers
Wet Etching	$HNO_3/HF/H_20$ $H_3PO_4/HNO_3/Acetic/H_20$ $H_3PO_4/HNO_3/HF/H_20,H_3PO_4$	25–180	Suggested Compound	Suitable Alternate	Consult DuPont Performance Elastomers
Photolithography Developing, Stripping, Rinsing	H_2SO_4 + Oxidant Organic Acids Chromic/Sulfuric Acid	25–125	Suggested Compound	Suitable Alternate	Consult DuPont Performance Elastomers
	NaOH, TMAH Xylene, Stoddard Solvent nMP	25–125	Suggested Compound	Suitable Alternate	Consult DuPont Performance Elastomers
	NMP/Alkanolamine DMSO/MEA DMAC/DEA Hydroxylamine	25–125	Suggested Compound	Consult DuPont Performance Elastomers	Suitable Alternate
Copper Plating	$CuSO_4$ Solution H_2SO_4, H_2O_2 UPDI, Citric Acid	25–100	Suggested Compound	Suitable Alternate	Consult DuPont Performance Elastomers

* Refer to the DuPont Performance Elastomers Chemical Resistance Guide for specific chemical and compound compatibility in semiconductor applications.

Note: Compound ratings are based on a combination of chemical resistance and extractable performance. In applications where extractables are not a critical concern, multiple compounds may be appropriate. For further assistance, contact DuPont Performance Elastomers and ask to speak with a Kalrez® Applications Engineer.

Kalrez® Offers Excellent Resistance to Chemical Attack

For many applications, low volume swell of elastomers is critical for proper equipment operation. Excessive swell may cause permanent seal failure due to equipment hang-up, extrusion, etc. While other physical property testing may be needed to adequately define product performance in a particular application, volume swell is an excellent indicator of resistance to chemical attack. The following data represents a summary of internal and external compatibility tests performed to determine the volume swell of compounds suggested for semiconductor wet process environments.

Immersion Chemistry	Exposure Conditions	Volume Swell		
		Kalrez® 6375UP	Kalrez® 4079UP	Kalrez® 1050UP
UPDI Water	85°C, 30 days	0.7	2.3	5.5
Piranha	25°C, 30 days	0.1	0.1	0.1
SC-1	25°C, 30 days	0.6	1.1	0.6
SC-2	25°C, 30 days	0.1	0.1	0.2
49% HF	25°C, 30 days	2.8	0.6	1.8
Ammonium Hydroxide	100°C, 7 days	2.6	9.8	Not Tested
Sulfuric Acid (H_2SO_4)	120°C, 30 days	1.3	0.8	2.8
Nitric Acid (HNO_3)	85°C, 7 days	2.1	1.5	Not Tested
Phosphoric/Acetic/Nitric Acid	60°C, 28 days	1.0	1.0	Not Tested
Hydrofluoric Acid/HNF_4	60°C, 28 days	0.0	1.0	Not Tested
Hydrochloric, Nitric Acid and H_2O	60°C, 28 days	5.0	6.0	Not Tested
n-Methylpyrrolidone	80°C, 7 days	2.0	2.4	3.2
Dimethyl Acetimide	80°C, 7 days	2.4	4.0	4.4
ACT 690C™[1]	95°C, 10 days	1.5	7.9	2.0
ACT-NP870™[1]	80°C, 10 days	2.0	6.2	2.0
ACT 935™[1]	80°C, 10 days	1.6	5.1	1.8
ACT NE-14™[1]	25°C, 10 days	0.0	0.0	0.3
ACT CMI™[1]	80°C, 10 days	2.7	6.5	5.2
EKC265™[2]	75°C, 7 days	1.0	2.8	0.7
EKC830™[2]	75°C, 7 days	3.1	10.0	10.1
EKC4000™PCT[2]	75°C, 7 days	0.7	1.7	2.5
PRS-1000®[3]	95°C, 10 days	1.5	7.9	2.0
PRS-3000™[3]	80°C, 10 days	2.0	6.2	2.0
ALEG™310[3]	80°C, 10 days	1.6	5.1	1.8
REZI™28[3]	80°C, 10 days	2.7	6.5	5.2

* Note: The volume swell values above should be used as an approximate indicator of relative compatibility performance. Generally <10% volume swell is desirable.

[1]Ashland, Inc.

[2]EKC Technologies, Inc.

[3]J.T. Baker (A Division of Mallincrkrodt Baker, Inc.)

Keep Contamination Under Control with Kalrez®

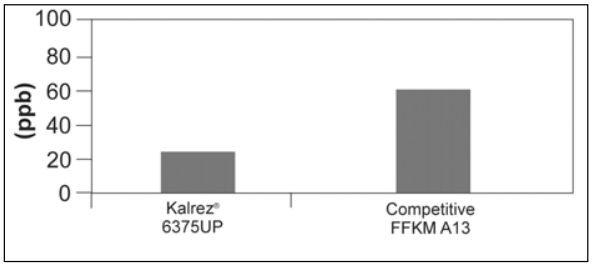
Semiconductor devices are vulnerable to many types of contaminants including trace chemicals (anions and total organic carbons—TOCs), metallic ions, and particles.

Chemical Contamination (anions and TOCs)

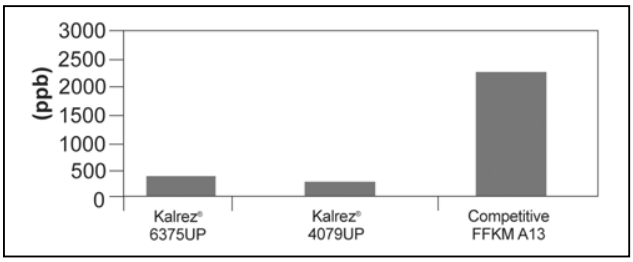
Two of the major sources of contamination in semiconductor processes are trace elements of unwanted chemicals (anions) and organic contaminants (TOCs). Process chemicals and process water can become contaminated and interfere with wafer processing. Chlorine (i.e., chloride ion) is such a contaminant and is rigorously controlled in process chemicals. In UPDI systems, TOCs can adhere to wafer surfaces and adversely affect oxide quality or film quality.

Elastomeric seals can be a source of this contamination. DuPont Performance Elastomers has developed compounds to minimize the potential for chemical and organic contamination.

Chloride Ion Extractables After Immersion in UPDI Water for 1 Month at 85°C*



Total Oxidizable Carbon After Immersion in UPDI Water for 1 Month at 85°C*

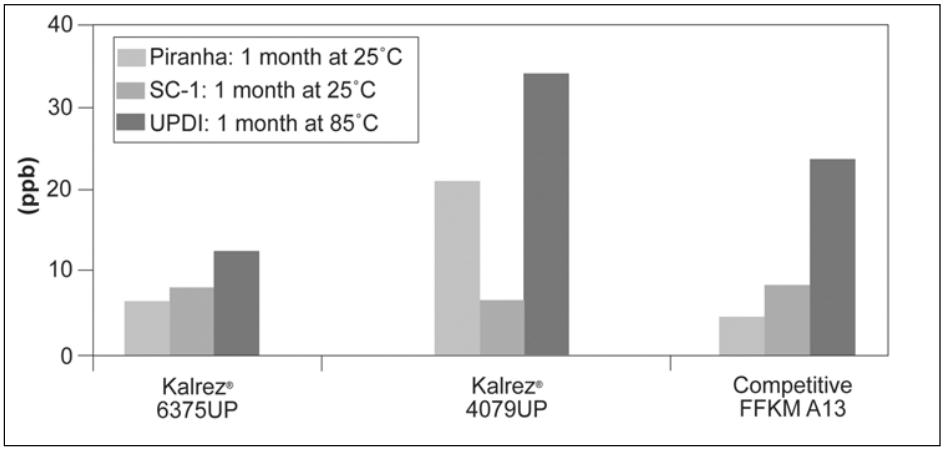


*DuPont Performance Elastomers Extractables Test Procedure

Metallic Ion Contamination

Process chemicals can cause metallic ions to leach out of seal materials. These metallic ions, depending on type and quantity, can alter electrical properties and cause device failure to occur. Below is a summary of total metallic extractables after immersion of O-rings in various cleaning and wafer preparation process chemicals. Kalrez® 6375UP has an excellent balance of chemical resistance and low metallic extractables in a variety of process fluids.

Total Metallic Extractables by ICP-MS*



*DuPont Performance Elastomers Extractables Test Procedure

Particle Contamination

As device feature sizes continue to become smaller, greater emphasis must be placed on reducing the potential for particle contamination (both size and quantity). The post-cleaning process used by DuPont Performance Elastomers for all Kalrez® UltraPure™ parts results in part cleanliness levels significantly superior to those available from other perfluoroelastomer part suppliers as shown by recent independent laboratory comparison tests. This process can reduce, by a factor of 20, the number of particles >1 micron in size present on the part surface. For additional information on Ultrapure Processing, refer to Technical Information Bulletin “UltraPure Post Cleaning Process Dramatically Reduces Particulate Contamination on the Surface of Kalrez® Parts.”

Typical Physical Properties[1]

Compound	Color	Hardness Shore A (pellet)[2]	Hardness Shore M (O-ring)[3]	Max. Cont. Service Temp,[6] °C	100% Modulus[4] MPa	Compression Set[5] at 70 hr 204°C, %
6375UP	Black	75	83	275	7.23	25
4079UP	Black	75	83	316	7.23	25
1050UP	Black	82	-	288	12.40	35

[1] Not to be used for specification purposes
[2] ASTM D2240 (pellet test specimens)
[3] ASTM D2240 and ASTM D1414 (AS568A K214 O-ring test specimens)
[4] ASTM D412 (dumbbell test specimens)
[5] ASTM D395 (pellet test specimens)
[6] DuPont Prformance Elastomers proprietary test method

For further information please contact one of the offices below, or visit our website at
www.dupontelastomers.com/kalrez

Global Headquarters – Wilmington, DE USA
Tel. +1-800-853-5515
+1-302-792-4000
Fax +1-302-792-4450

European Headquarters - Geneva
Tel. +41-22-717-4000
Fax +41-22-717-4001

South & Central America Headquarters - Brazil
Tel. +55-11-4166-8978
Fax +55-11-4166-8989

Asia Pacific Headquarters - Singapore
Tel. +65-6275-9383
Fax +65-6275-9395

Japan Headquarters – Tokyo
Tel. +81-3-6402-6300
Fax. +81-3-6402-6301

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