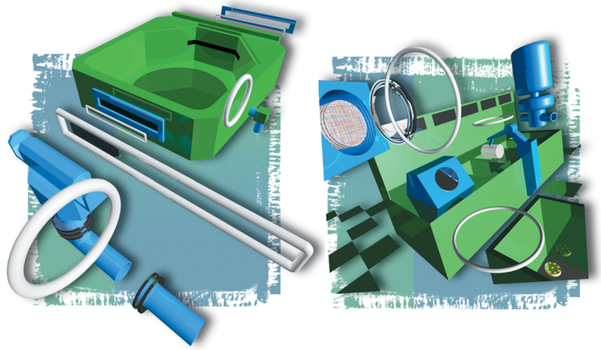

Semiconductor Seal Compound

Selection Guide

Greene Tweed
The Inside Advantage®

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Seal Selection Criteria

No one notices a critical seal until it fails. While seal failure over time is inevitable, a seal will deliver a higher level of performance and a longer, more predictable life if key criteria are considered when selecting seal materials and geometries. Selecting the optimum sealing system for semiconductor production equipment requires matching application requirements and application conditions with seal compound properties and design. Many Greene, Tweed products are a result of cooperative efforts between Greene, Tweed and leading semiconductor equipment manufacturers and forward-looking fabs.

The key criteria used to define overall sealing system performance are:

Application Requirements

- Life expectancy
- Leakage limits
- Fluid/gas compatibility
- Material degradation
- Contamination
- Economic benefits
- Ease of use

Application Conditions

- Hardware dimensions
- Surface finishes
- Process chemicals
- Operating temperatures
- Pressures
- Cycle times

Seal Compound Properties

- Physical
- Mechanical
- Thermal

Seal Design

- Sizing
- Installation requirements
- Hardware design

The Seal Compound Selection Guide was developed to help our customers select the elastomeric compound that will optimize performance in a specific sealing application. Compound selection information assumes that the optimum specific seal design or geometry has been previously selected. Recommendations are based on Greene, Tweed knowledge and experience with the various process systems and components indicated. Please contact our dedicated team of chemists, chemical and mechanical engineers, customer service specialists and production technicians if you require assistance solving your processing challenges.

Chemraz® Perfluoroelastomer and Fluoroelastomer Selection Guide

Compound Name	Handling, Cleaning, Packaging, Designator Options	Compound Type	Compound Color	Service Temperature Range (°C)	Specific Gravity	Hardness (Shore A)	Compression Set (%)*	Tensile Strength psi (kPa)	Elongation (%)	Modulus 50% Elongation psi (kPa)	Modulus 100% Elongation psi (kPa)
Chemraz® 513	SC SS	Perfluoro	White	-30 to 210	2.22	80	25	1660 (11032)	165	540 (3723)	1050 (7239)
Chemraz® 520	SC SS	Perfluoro	White	-30 to 240	2.10	90	35	1950 (13445)	110	990 (6826)	1780 (12273)
Chemraz® 550	SD	Perfluoro	Black	-30 to 210	1.93	75	25	1750 (12066)	140	450 (3103)	1150 (7929)
Chemraz® 570	SD	Perfluoro	White	-30 to 210	1.98	70	35	1300 (8963)	145	350 (2413)	780 (5378)
Chemraz® 571	SD	Perfluoro	White	-30 to 210	1.99	80	35	1550 (10687)	130	625 (4309)	1240 (8549)
Chemraz® 592	SS	Perfluoro	White	-30 to 240	2.07	80	36	2100 (14479)	120	700 (4826)	1770 (12204)
Chemraz® 653	SD	Perfluoro	Black	-15 to 325	1.99	80	14 26†	1830 (12618)	135	360 (2482)	1090 (7516)
Chemraz® E38	SS	Perfluoro	White	-20 to 260	1.99	80	21	2200 (15169)	150	410 (2827)	1100 (7585)
Fluoroelastomer 742	SP	Fluorocarbon	Black	-30 to 250	1.82	75	20	2050 (14134)	182	600 (4137)	1026 (7074)
Fluoroelastomer 931	SP	Fluorocarbon	Black	-30 to 250	1.84	90	27	2245 (15479)	144	936 (6453)	1625 (11204)

* 70 hours @ 204°C @ 25% deflection
† 70 hours @ 288°C @ 25% deflection

Product Handling, Cleaning and Packaging Designators

The handling, cleaning and packaging of elastomeric seals, for use in semiconductor equipment, can be as critical to the performance of the seal as the seal material. One of the following designators is included in each Greene, Tweed part number.

SD – Semiconductor grade product with special handling using gloves during processing. Product is washed with deionized water (DI) and inspected to semiconductor standards. Class 100 packaging in double plastic bags.

SS – Semiconductor grade product with special handling using gloves during processing. Product is washed with a solvent mixture (50/50 isopropyl alcohol and heptane) and inspected to semiconductor standards. Class 100 packaging in double plastic bags.

SP – Industrial grade product without special handling using gloves during processing. Product is washed with isopropyl alcohol and is inspected to industrial standards. Standard packaging in single plastic bags.

SC – Semiconductor grade product with special handling using gloves during processing. Product is inspected to semiconductor standards. Standard packaging in single plastic bags.

Process Applications Guide

Compound Name	Features and Benefits	Service Temperature Range (˚C)	Wet vs. Dry	Static vs. Dynamic	Primary Choices for Processes (Bold)	Applications
Chemraz® 513	Good plasma resistance Good physical properties Minimal contamination Excellent performance history as "universal product"	-30 to 210˚C	Dry	Static	**Metalization (CVD, PVD, sputtering, evaporation)** **Deposition (CVD, PECVD, RPCVD, HDPCVD, APCVD, SACVD, DCVD)** **Dry Plasma Etch** **Remote Plasma Cleans** **Dry Ashing** Ion Implant Implant Anneal RTP	Door Seals, Slit Valves, Window Seals, Isolator Valve Seals, Lid Seals, Gas Inlet Seals, KF Fitting Seals
Chemraz® 520	Excellent plasma resistance Outstanding physical properties Low contaminants Withstands higher sealing loads Excellent performance history in higher temperature applications	-30 to 240˚C	Dry	Static and Dynamic	**Metalization (CVD, PVD, sputtering, evaporation)** **Deposition (CVD, PECVD, RPCVD, HDPCVD, APCVD, SACVD, DCVD)** **Dry Plasma Etch** **Remote Plasma Cleans** **Dry Ashing** Oxidation (LPCVD) Diffusion Ion Implant Implant Anneal RTP	Door Seals, Slit Valves, Window Seals, Isolator Valve Seals, Lid Seals, Gas Inlet Seals, KF Fitting Seals
Chemraz® 550	Good chemical resistance Good physical properties Used where contamination requirements are less critical Excellent performance history	-30 to 210˚C	Wet	Static and Dynamic	Wet Etch (acid, base) Wet Stripping (solvents) Wet Cleaning (UPDI) Wet Metal Plating	Valve Seals, Fitting and Union Seals, Gaskets, Regulator Seals, Filter Seals
Chemraz® 570 **Chemraz® 571**	Very low contaminants Extended performance and added reliability Good physical properties Excellent performance history in wet systems	-30 to 210˚C	Wet	Static	**Wet Etch (acid, base)** **Wet Stripping (solvents)** **Wet Cleaning (UPDI)** Wet Metal Plating Chemical Mechanical Planarization (CMP)	Valve Seals, Fitting and Union Seals, Gaskets, Regulator Seals, Filter Seals
Chemraz® 592	Excellent physical properties Inert filler system ensures excellent resistance to plasma attack	-30 to 240˚C	Dry	Static and Dynamic	**Dry Ashing (O_2)** Oxidation (LPCVD) Diffusion Metalization (CVD, PVD, sputtering, evaporation) Deposition (CVD, PECVD, RPCVD, HDPCVD, APCVD, SACVD, DCVD) Dry Plasma Etch Remote Plasma Cleans Ion Implant Implant Anneal RTP	Slit Valves, Endpoint Windows, Window Seals, Valve Seals, Lid Seals, Gas Inlet Seals, KF Fitting Seals, Isolator Valve Seals, Bell Jar Seals

Compound Name	Features and Benefits	Service Temperature Range (˚C)	Wet vs. Dry	Static vs. Dynamic	Primary Choices for Processes (Bold)	Applications
Chemraz® 653	Excellent plasma resistance Used where contamination requirements are less critical Suitable for higher temperature applications Superior compression set	-15 to 325˚C	Dry	Static and Dynamic	**Oxidation (LPCVD)** **Diffusion** **RTP** Metalization (CVD, PVD, sputtering, evaporation) Deposition (CVD, PECVD, RPCVD, HDPCVD, APCVD, SACVD, DCVD) Dry Plasma Etch Remote Plasma Cleans Dry Ashing Implant Anneal	Quartz Rod Seals, Bell Jar Seals, High-Temperature Valve Seals, KF Fitting Seals
Chemraz® E38	Minimal contamination Withstands a variety of aggressive chemicals Excellent physical properties Low metal ion content Unlimited design flexibility Suitable for higher temperature applications	-20 to 260˚C	Dry	Static and Dynamic	**Deposition (CVD, PECVD, RPCVD, HDPCVD, APCVD, SACVD, DCVD)** **Remote Plasma Cleans** Oxidation (LPCVD) Diffusion Metalization (CVD, PVD, sputtering, evaporation) Dry Plasma Etch Dry Ashing Ion Implant Implant Anneal RTP	Bonded Gate Seals, Chamber Seals
Fluoroelastomer 742	Outstanding physical properties Conforms well to handware features Used where contamination requirements are less critical Good performance history in chemically aggressive systems	-30 to 250˚C	Dry and Wet	Static and Dynamic	**Metalization (CVD, PVD, sputtering, evaporation)** **Ion Implant** Oxidation (LPCVD) Diffusion Deposition (CVD, PECVD, RPCVD, HDPCVD, APCVD, SACVD, DCVD) Dry Plasma Etch Remote Plasma Cleans Dry Ashing Wet Etch (acid, base) Wet Cleaning (UPDI) Wet Metal Plating Implant Anneal RTP	Door Seals, Slit Valves, Window Seals, Lid Seals, Gas Inlet Seals, KF Fitting Seals, Valve Seals, Gaskets, Fitting and Union Seals
Fluoroelastomer 931	Outstanding physical properties Used where contamination requirements are less critical Superior performance under higher sealing loads Good performance history in chemically aggressive systems	-30 to 250˚C	Dry and Wet	Static and Dynamic	**Ion Implant** Oxidation (LPCVD) Diffusion Metalization (CVD, PVD, sputtering, evaporation) Deposition (CVD, PECVD, RPCVD, HDPCVD, APCVD, SACVD, DCVD) Dry Plasma Etch Remote Plasma Cleans Dry Ashing Wet Etch (acid, base) Wet Cleaning (UPDI) Wet Metal Plating Implant Anneal RTP	Door Seals, Slit Valves, Window Seals, Lid Seals, Gas Inlet Seals, KF Fitting Seals, Valve Seals, Gaskets, Fitting and Union Seals

Chemical Compatibility Guide — Dry Chemicals

Ratings are based on ambient temperature, low pressure and 100% concentrations. Exposure conditions that differ from these may affect ratings. Seal material selection is dependent on more than just chemical compatibility. Seal geometries, hardware design and application conditions are also factors in material selection. The compatibility data presented are based on the material's polymer content only. If you need assistance, please contact your local Greene, Tweed representative when selecting the appropriate Greene, Tweed product for your specific application.

Chemraz® Perfluoroelastomer and Fluoroelastomer Selection Guide

Environment	Chemical Formula	Chemraz®								Fluoroelastomer	
		513	520	550	570	571	592	653	E38	742	931
Ammonium Fluoride	NH_4F	E	E	E	E	E	E	E	E	G	G
Acetylene	C_2H_2	E	E	E	E	E	E	E	E	E	E
Ammonia	NH_3	E	E	E	E	E	E	E	E	P	P
Argon	Ar	E	E	E	E	E	E	E	E	E	E
Arsenic Chloride	AsCl	E	E	E	E	E	E	E	E	P	P
Arsenic Trichloride	$AsCl_3$	E	E	E	E	E	E	E	E	P	P
Arsine	AsH_3	E	E	E	E	E	E	E	E	F	F
Boron Tribromide	BBr_3	E	E	E	E	E	E	E	E	E	E
Boron Trichloride	BCl_3	G	G	G	G	G	G	G	G	E	E
Boron Trifluoride	BF_3	G	G	G	G	G	G	G	G	E	E
Bromine	Br	E	E	E	E	E	E	E	E	E	E
Carbon Dioxide	CO_2	E	E	E	E	E	E	E	E	G	G
Carbon Tetrachloride	CCl_4	G	G	G	G	G	G	G	G	E	E
Carbon Tetrafluoride	CF_4	G	G	G	G	G	G	G	G	E	E
Chlorine	Cl_2	G	G	G	E	E	G	G	G	E	E
Chloropentafluoroethane (F-115)	C_2F_5Cl	G	G	G	G	G	G	G	G	E	E
Diborane	B_2H_6	E	E	E	E	E	E	E	E	G	G
Dichlorodifluoromethane (F-12)	CCl_2F_2	G	G	G	G	G	G	G	G	G	G
Dichlorosilane	SiH_2Cl_2	E	E	E	E	E	E	E	E	G	G
Dimethylamine (DMA)	$(CH_3)_2NH$	G	G	G	G	G	G	G	G	P	P
Disilane	Si_2H_6	E	E	E	E	E	E	E	E	G	G
Difluoroethane (F-152A)	CH_3CHF_2	G	G	G	G	G	G	G	G	P	P
Fluorine	F_2	G	G	G	G	G	G	G	G	G	G
Fluoroform (F-23)	CHF_3	E	E	E	E	E	E	E	E	P	P
Germanium Tetrahydride	GeH_4	E	E	E	E	E	E	E	E	G	G
Helium	He	E	E	E	E	E	E	E	E	E	E
Hexachlorodisilane	Si_2Cl_6	E	E	F	E	E	E	E	E	G	G
Hexafluoroethane (F-116)	C_2F_6	G	G	G	G	G	G	G	G	G	G
Hydrogen	H_2	E	E	E	E	E	E	E	E	E	E
Hydrogen Bromide	HBr	E	E	E	E	E	E	E	E	E	E

Environment	Chemical Formula	Chemraz®								Fluoroelastomer	
		513	520	550	570	571	592	653	E38	742	931
Hydrogen Chloride	HCl	G	G	E	E	E	G	E	G	E	E
Hydrogen Fluoride	HF	E	E	E	E	E	E	E	E	P	P
Hydrogen Selenide	H_2Se	E	E	E	E	E	E	E	E	F	F
Hydrogen Sulfide	H_2S	G	G	E	G	G	G	E	G	P	P
Methyl Chloride	CH_3Cl	E	E	E	E	E	E	E	E	E	E
Monomethylamine	CH_5N	G	G	G	G	G	G	G	G	F	F
Nitrogen	N_2	E	E	E	E	E	E	E	E	E	E
Nitrogen Trifluoride	NF_3	E	E	G	G	G	E	G	E	G	G
Nitrous Oxide	N_2O	E	E	E	E	E	E	E	E	E	E
Oxygen	O_2	E	E	P	E	E	E	P	E	P	P
Ozone	O_3	E	E	G	E	E	E	G	E	E	E
Perfluoropropane	C_3F_8	G	G	G	G	G	G	G	G	P	P
Phosphine	PH_3	E	E	E	E	E	E	E	E	F	F
Phosphorus Trifluoride	PF_3	E	E	E	E	E	E	E	E	E	E
Potassium Hydroxide	KOH	P	P	E	G	G	F	E	F	P	P
Silane	SiH_4	E	E	E	E	E	E	E	E	G	G
Silicon Tetrachloride	$SiCl_4$	G	G	G	G	G	G	G	G	G	G
Silicon Tetrafluoride	SiF_4	G	G	G	G	G	G	G	G	P	P
Silicon Trifluoride	SiF_3	G	G	G	G	G	G	G	G	P	P
Sodium Hydroxide	$NaOH$	P	P	E	G	G	F	E	F	G	G
Sulfur Hexafluoride	SF_6	G	G	G	G	G	G	G	G	F	F
Tetraethylorthosilicate (TEOS)	$(C_2H_5)_4SiO_4$	E	E	E	E	E	E	E	E	E	E
Tetrafluoromethane (F-14)	CF_4	E	E	G	G	G	E	G	E	E	E
Trichloroethane	$C_2H_3Cl_3$	E	E	E	E	E	E	E	E	E	E
Trichlorosilane	$SiHCl_3$	E	E	G	G	G	E	E	G	G	G
Trifluoromethane	CHF_3	E	E	E	E	E	E	E	E	G	G
Trimethylamine	$(CH_3)_3N$	G	G	G	G	G	G	G	G	P	P
Trisilane	Si_3H_6	E	E	E	E	E	E	E	E	G	G
Tungsten Hexafluoride	WF_6	E	E	G	E	E	E	G	E	F	F

E = Excellent   G = Good   F = Fair   P = Poor

Chemical Compatibility Guide — Wet Chemicals

Ratings are based on ambient temperature, low pressure and 100% concentrations. Exposure conditions that differ from these may affect ratings. Seal material selection is dependent on more than just chemical compatibility. Seal geometries, hardware design and application conditions are also factors in material selection. The compatibility data presented are based on the material's polymer content only. If you need assistance, please contact your local Greene, Tweed representative when selecting the appropriate Greene, Tweed product for your specific application.

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Environment	Chemical Formula	Chemraz®								Fluoroelastomer	
		513	520	550	570	571	592	653	E38	742	931
Acetic Acid (10%)	CH_3COOH	F	F	F	F	F	F	F	F	G	G
Acetic Acid, glacial	CH_3COOH	P	P	F	E	E	F	F	F	P	P
Acetone	CH_3COCH_3	E	E	E	E	E	E	E	E	P	P
Ammonium Fluoride (40%)	NH_4F	P	P	E	E	E	F	E	F	G	G
Ammonium Hydroxide (conc.)	NH_4OH	F	F	E	E	E	G	E	E	F	F
Aqua Regia	HNO_3:HCl	F	F	G	E	E	F	G	F	P	P
Buffered Oxide Etchants (BOE)	NH_4F:HF	P	P	E	E	E	F	E	F	G	G
Butanol	$C_4H_{10}O$	E	E	E	E	E	E	E	E	G	G
Butyl Acetate	$CH_3COO(CH_2)_3CH_3$	E	E	E	E	E	E	E	E	P	P
Carbon Tetrachloride	CCl_4	G	G	G	G	G	G	G	G	G	G
Cellusolve Acetate	$CH_3COOCH_2CH_2OCH_2CH_3$	E	E	E	E	E	E	E	E	P	P
Chromic Acid	CrO_3:(H_2CrO_4)	P	P	E	E	E	F	E	P	G	G
Cyclohexane	C_6H_{12}	E	E	E	E	E	E	E	E	G	G
Cyclohexanone	$C_6H_{10}O$	G	G	G	E	E	G	G	G	P	P
Deionized Water	H_2O	P	P	E	E	E	F	E	F	F	F
Dimethylsulfoxide (DMSO)	$(CH_3)_2SO$	E	E	E	E	E	E	E	E	P	P
Ethylene Glycol Mono Methyl Ether Acetate (EGMEA)	$CH_3CH_2OCH_2CH_2COOCH_3$	G	G	G	G	G	G	G	G	E	E
Ethylene Glycol Methyl Ether Acetate (EGMEEA)	$CH_3COOCH_2CH_2OC_2H_5$	G	G	G	G	G	G	G	G	E	E
Ethanol	CH_3CH_2OH	E	E	E	E	E	E	E	E	G	G
Ethyl Acetate	$CH_3COOC_2H_5$	E	E	E	E	E	E	E	E	P	P
Ethyl Lactate	$CH_3CH_2OCOOC_2H_5$	E	E	E	E	E	E	E	E	P	P
Ethylene Glycol	CH_2OHCH_2OH	E	E	E	E	E	E	E	E	G	G
Freon TF	CCl_2FCClF_2	P	P	P	P	P	P	P	P	G	G
Glycerol	$C_3H_5(OH)_3$	E	E	E	E	E	E	E	E	E	E
Heptane	$CH_3(CH_2)_5CH_3$	E	E	E	E	E	E	E	E	G	G
Hexamethyldisilazane (HMDS)	$(CH_3)_3SiNHSi(CH_3)_3$	E	E	E	E	E	E	E	E	P	P
Hexane	$CH_3(CH_2)_4CH_3$	E	E	E	E	E	E	E	E	G	G
Hydrochloric Acid (conc.)	HCl	P	P	E	E	E	F	E	F	G	G
Hydrofluoric Acid (49%)	HF	P	P	E	E	E	F	E	F	G	G
Hydrofluoric Acid (dilute)	HF	P	P	E	E	E	F	E	F	G	G
Hydrogen Peroxide (30%)	H_2O_2	E	E	G	E	E	E	G	E	G	G
Isobutanol	$C_4H_{10}O$	E	E	E	E	E	E	E	E	G	G
Isopropanol (IPA)	$CH_3CHOHCH_3$	E	E	E	E	E	E	E	E	G	G
Methanol	CH_3OH	E	E	E	E	E	E	E	E	F	F

Environment	Chemical Formula	Chemraz®								Fluoroelastomer	
		513	520	550	570	571	592	653	E38	742	931
Methyl Ethyl Ketone (MEK)	$CH_3COCH_2CH_3$	E	E	E	E	E	E	E	E	P	P
Methyl Isobutyl Ketone (MIBK)	$(CH_3)_2CHCH_2COCH_3$	E	E	E	E	E	E	E	E	P	P
Methylene Chloride	CH_2Cl_2	E	E	E	E	E	E	E	E	G	G
Mixed Acid Etch; (HNO_3<20%)	—	P	P	E	E	E	F	E	F	F	F
Monoethanolamine (MEA)	$HOCH_2CH_2NH_2$	G	G	G	G	G	G	G	G	P	P
Nitric Acid (conc.)	HNO_3	P	P	E	E	E	F	E	F	G	G
N-Methyl Pyrrolidone (nMP)	$CH_3OCH_2OCH_2CH_2OH$	E	E	E	E	E	E	E	E	P	P
Neutral Oxide Etchants (NOE)	Ethylene Glycol/nNH_4F:H_2O:Surfactant	P	P	E	E	E	F	E	F	G	G
Ozonated Deionized Water	O_3:H_2O	P	P	G	E	E	F	G	F	G	G
Propylene Glycol Mono Methyl Ether Acetate (PGMEA)	—	E	E	E	E	E	E	E	E	P	P
Pentane	$CH_3(CH_2)_3CH_3$	E	E	E	E	E	E	E	E	G	G
P-Etch	HNO_3:HF:DI H_2O (3:5:92)	P	P	G	E	E	F	G	F	G	G
Petroleum Ether	—	E	E	E	E	E	E	E	E	G	G
Phosphoric Acid (conc.)	H_3PO_4	P	P	E	E	E	F	E	F	G	G
Piranha	H_2SO_4:H_2O_2	P	P	E	E	E	F	E	F	G	G
Potassium Hydroxide (conc.)	KOH	P	P	E	E	E	F	E	F	F	F
Propylene Glycol	$CH_3CHOHCH_2OH$	E	E	E	E	E	E	E	E	G	G
RCA Etch	H_3PO_4:CH_3CO_2H:HNO_3:DI H_2O (75:15:5:5)	P	P	E	E	E	F	E	F	G	G
SC1	NH_4OH:H_2O_2:DI H_2O	P	P	E	E	E	F	E	F	G	G
SC2	HCl:H_2O_2:DI H_2O	P	P	E	E	E	F	E	F	G	G
Silicone Oils	—	E	E	E	E	E	E	E	E	G	G
Sodium Hydroxide (conc.)	NaOH	P	P	E	E	E	F	E	F	F	F
Sulfuric Acid (conc.)	H_2SO_4	P	P	E	E	E	F	E	F	G	G
Tetrachloroethylene (Perchloroethylene)	C_2Cl_4	E	E	E	E	E	E	E	E	E	E
Tetramethyl Ammonium Hydroxide (TMAH) 5%	$(CH_3)_4NOH$	F	F	G	E	E	F	F	F	F	F
Tetramethylcyclotetrasiloxane (TMCTS)	$(HSi(CH_3)O)_4$	E	E	E	E	E	E	E	E	G	G
Toluene	$C_6H_5CH_3$	E	E	E	E	E	E	E	E	G	G
Trichloroethane	$C_2H_3Cl_3$	E	E	E	E	E	E	E	E	G	G
Trichloroethylene	$CHCl$:CCl_2	E	E	E	E	E	E	E	E	G	G
Trichlorofluoromethane (F-11)	$C_{l3}SiC_6H_5$	G	G	G	G	G	G	G	G	G	G
Trichlorosilane	$SiHCl_3$	E	E	E	E	E	E	E	E	G	G
Trichlorotrifluoroethane (F-113)	CCl_2FCClF_2	G	G	G	G	G	G	G	G	G	G
Xylene	$C_6H_4(CH_3)_2$	E	E	E	E	E	E	E	E	G	G

E = Excellent G = Good F = Fair P = Poor

Permeability and Thermal Expansion

Gas Permeability

No standard test has been established for checking gas permeability rates on seals. Many test methods are used with different units for each depending on the test method chosen. The compilation below is a combination of published data and Greene, Tweed testing. The numbers are average rates since the test method and material characteristics of each sample impact the results. When permeability is a critical parameter, contact Greene, Tweed Semiconductor Engineering for recommendations.

Material	Permeability Rate ($cm^3 \cdot cm/sec \cdot cm^2 \cdot atm$)	
	Helium	Oxygen
Silicone Rubber	251.7×10^{-8}	214.5×10^{-8}
Perfluoroelastomer	68.3×10^{-8}	24.2×10^{-8}
Fluoroelastomer	12.3×10^{-8}	1.7×10^{-8}
Butyl Rubber	5.8×10^{-8}	0.9×10^{-8}

Coefficient of Thermal Expansion

The coefficient of thermal expansion test was performed over a range of 10˚C to 150˚C with a heating rate of 5˚C/minute.

Material	Coefficient of Thermal Expansion — (cm/cm/˚C)
Silicone Rubber	19.3×10^{-5}
Perfluoroelastomer	17.6×10^{-5}
Fluoroelastomer	16.4×10^{-5}
Butyl Rubber	15.1×10^{-5}
Stainless Steel (ref.)	0.6×10^{-5}

Effects of Available Compressive Force on Seal Design

The compressive force required for an O-ring to effect a seal is as important as the seal's size, durometer and chemical compatibility. Inadequate squeeze on the cross-section of an O-ring reduces the sealing footprint and can cause failure. The following factors must be considered for optimum seal integrity:

- A squeeze of 20-25% for static and 12-18% for dynamic applications

- Dimensional tolerances of seals and equipment must be considered to prevent inconsistent compression and possible leakage

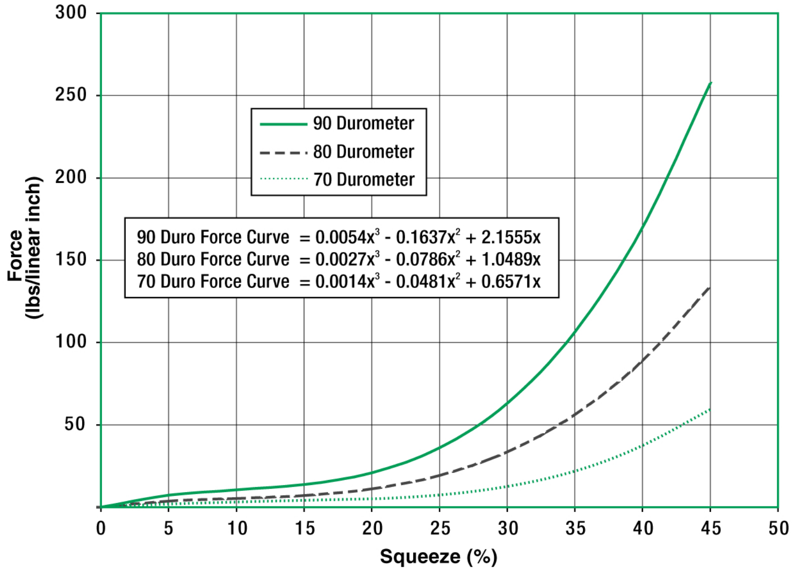
- Balance must be achieved between the physical properties of the seal material (e.g., hardness, tensile strength, modulus) and the compressive force of the application

- As temperature rises, so does gland fill and subsequent compression due to the thermal expansion of the seal material. Seal and gland designs may have to be adjusted to compensate for this expansion in high-temperature applications (>250°C).

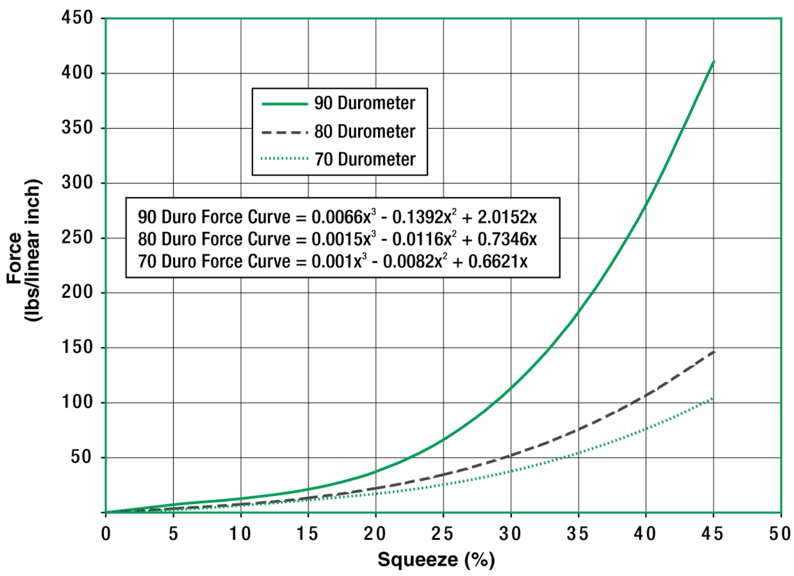
Average force curves approximate the force necessary to compress standard Chemraz® O-ring cross-sections at three hardness levels — 70, 80 and 90 Shore A, Hardness. The following graphs show the average O-ring compressive force curves for 0.070″, 0.103″, 0.139″, 0.210″ and 0.275″ cross-sections. Please consult Greene, Tweed Engineering to optimize seal designs while balancing the many trade-offs.

Average O-Ring Compressive Force

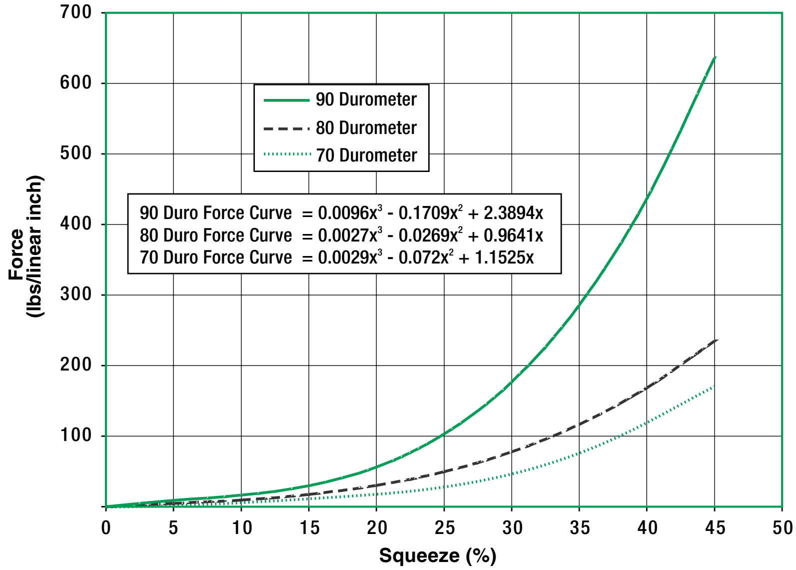
0.070" Cross-Section



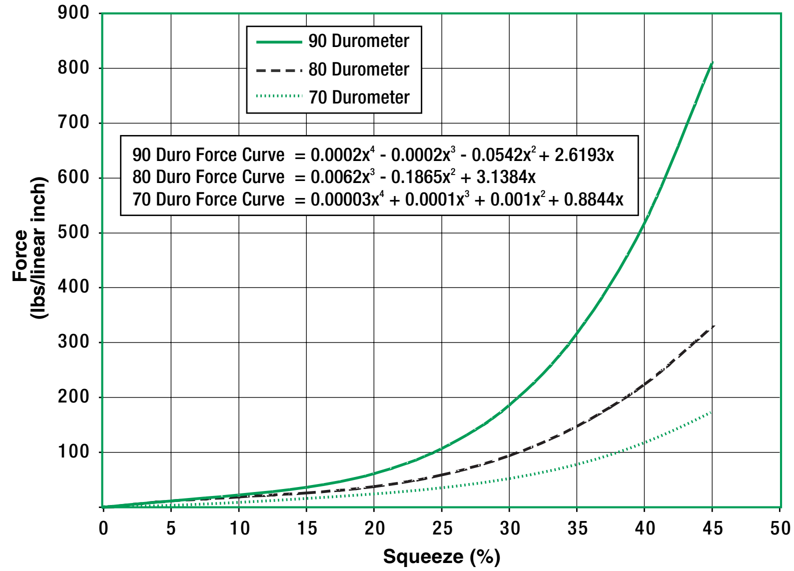
0.103" Cross-Section



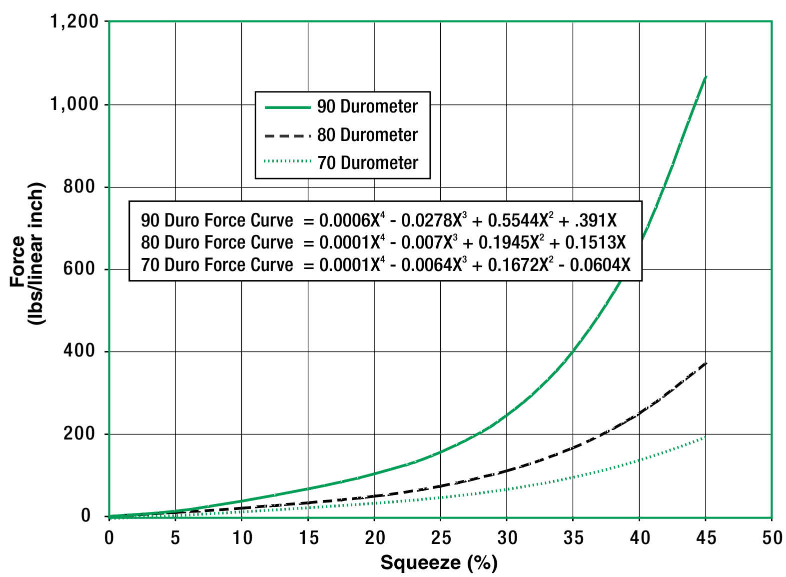
0.139" Cross-Section



0.210" Cross-Section



0.275" Cross-Section



Sales Request Form

Customer Service Request ❑ Engineering Request ❑

Salesperson: ______________________ Date: ______________

Contact Information

Customer: ______________________ Contact: ______________

Location: ______________________ Phone: ______________

______________________ Fax: ______________

______________________ E-mail: ______________

Contact Customer Direct: ________ With/Without Sales: ________ Other: ______________

Equipment Information

Manufacturer: ______________________ Chamber: ______________

Present Material: ______________________ PM Cycle: ______________

Part Location/Component: ______________________

Process: ______________________ Pressure/Vacuum: ______________

Wet/Dry: ______________ RF Energy: ________ Seal Temperature: ______________

Chemistry (Chemical and Concentration): ______________________

____

Problem: ______________________

____

History: ______________________

____

Application Needs ❑ Design ❑ PPA* ❑ Samples ❑ Quote ❑ Analysis ❑ Other

Objective: ______________________

Date Needed: ______________ Present Life: ______________ Desired Life: ______________

Requirements: ______________________

____

*Product Performance Analysis

Fax this form to your nearest Greene, Tweed office — Attn: Semiconductor Application Engineering

Seal Sizing

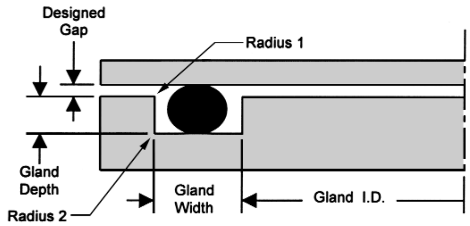
$$\text{Cross-Section Squeeze \%} = \left(\frac{\text{Seal Cross-Section} - \text{Gland Depth}}{\text{Seal Cross-Section}}\right) \times 100\%$$

$$\text{Diameter Stretch \% Rectangular Gland} = \left(\frac{\text{Gland Inner Diameter} - \text{Seal Inner Diameter}}{\text{Seal Inner Diameter}}\right) \times 100\%$$

$$\text{Gland Volume Fill \%} = \left(\frac{\text{Seal Volume}}{\text{Gland Volume}}\right) \times 100\%$$

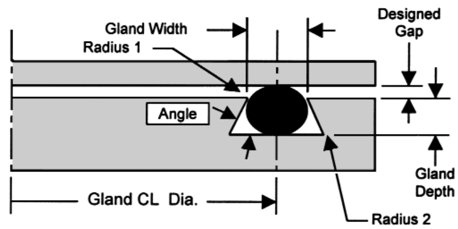
Seal Systems

Static Face Sealing System



Rectangular Face Seal Gland

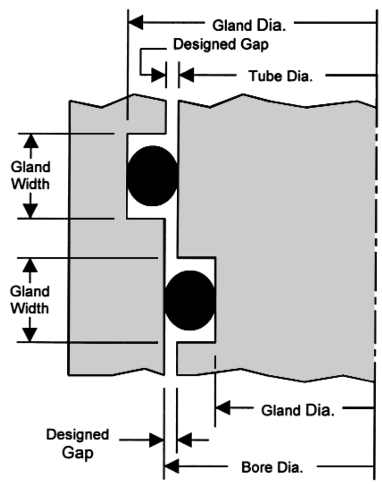
Gland (I.D.) Inside Diameter: _______
Gland Depth: _______
Gland Width: _______
Designed Gap: _______
Radius 1/Radius 2: _______



Dovetail Face Seal Gland

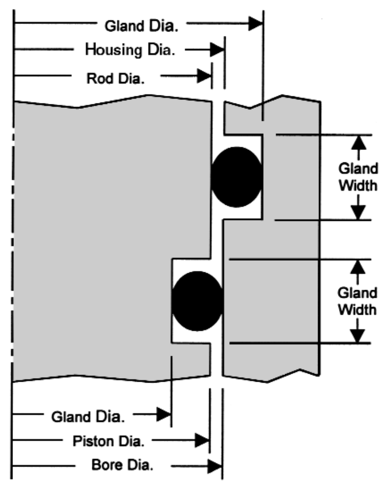
Gland (CL) Centerline Diameter: _______
Gland Depth: _______
Gland Width (to sharp corner): _______
Designed Gap: _______
Dovetail Angle: _______
Radius 1/Radius 2: _______

I.D. / O.D. Sealing Systems



Static Tube/Plug Seal Gland

Gland Width: _______
Gland Diameter: _______
Tube/Bore Diameter: _______
Designed Gap: _______



Dynamic Rod/Piston Seal Gland

Gland Width: _______
Gland Diameter: _______
Rod/Bore Diameter: _______
Housing/Piston Diameter: _______

Part Number Formats

When ordering Greene, Tweed seals, please consult Greene, Tweed customer service or the *Right Seal Handbook* and follow the part number format listed below:

Standard O-Rings

9 XXX – XX XXX

Example:

9 214 – SD 592

- 9 — O-Ring Designator
- 214 — AS 568A O-Ring Sizing Dash Number
- SD — Post-Production Handling, Cleaning and Packaging Designator
- 592 — Greene, Tweed Product Designator

Dovetail® Seals

4201 X XXX 00 – XX XXX

Example:

4201 B 255 00 – SD 592

- 4201 — Dovetail® Seal Designator
- B — Seal Orientation Designator (A or B)
- 255 — AS 568A O-Ring Sizing Dash Number
- 00 — Standard Dovetail® Seal Designator
- SD — Post-Production Handling, Cleaning and Packaging Designator
- 592 — Greene, Tweed Product Designator

MSE Seals

X XXXX – XXX X XXX

Example:

S 2155 – 202 S 357

- S — Seal Type:
  - R = Rod Seal
  - P = Piston Seal
  - E = External Pressure Face Seal
  - I = Internal Pressure Face Seal
  - S = Flange Seal
- 2155 — Seal Series:
  - 2000 = Finger Spring
  - 3000 = Coil Spring
- 202 — AS 568A O-Ring Sizing Dash Number
- S — Spring Material
- 357 — Jacket Material

Physical Constants		
k	Boltzmann's constant	1.3804 x 10^{-23} J/K
m_e	Rest mass of electron	9.108 x 10^{-31} kg
m_p	Rest mass of proton	1.672 x 10^{-27} kg
N_o	Avogadro's number	6.02252 x 10^{23}/(g-mole)
R	Gas constant	8314.3 J-(kg-mole)$^{-1}$-K^{-1}
V_o	Normal specific volume of an ideal gas	22.4136 m^3/(kg-mole)
σ	Stefan-Boltzmann constant	5.67 x 10^{-8} J-s^{-1}-m^{-1}-K^{-4}

SI Base Units		
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Amount of substance	kg-mole	kg-mole

Conversion Factors

Conventional unit →	multiply by →	to get SI unit
	Mass	
lb	0.45359	kg
	Length	
micrometer	0.000001	m
mil	0.00254	cm
inch	0.0254	m
foot	0.3048	m
angstrom	1.0×10^{-10}	m
	Area	
ft^2	0.0929	m^2
in^2	6.452	cm^2
ft^2	929.03	cm^2
	Volume	
cm^3	0.001	L
in^3	0.0164	L
gal (US)	3.7879	L
ft^3	28.3	L
L	1000	cm^3
	Pressure	
micrometer (Hg)	0.13332	Pa
N/m^2	1.0	Pa
millibar	100	Pa
Torr	133.32	Pa
in (Hg)	3386.33	Pa
lb/in^2	6895.3	Pa
atmosphere	101,323.2	Pa
	Conductance or pumping speed	
L/h	0.000277	L/s
L/s	0.001	m^3/s
L/min	0.0166	L/s
m^3/h	0.2778	L/s
ft^3/min	0.4719	L/s
ft^3/min	1.6987	m^3/h
To get conventional unit ←	**divide by ←**	**SI unit**

Conventional unit →	multiply by →	to get SI unit
Gas flow		
micron-L/s	0.13332	Pa-L/s
Pa-L/s	3.6	Pa-m^3/h
atm-cc/s	101.323	Pa-L/s
Torr-L/s	133.32	Pa-L/s
Torr-L/s	0.133	J/s
watt	1000	Pa-L/s
kg-mole/s (at 0˚C)	2.48×10^9	Pa-L/s
molecules/s (at 0˚C)	4×10^{-18}	Pa-L/s
Outgassing rate		
Pa-L/(m^2-s)	0.001	W/m^2
Pa-m^3/(m^2-s)	1.0	W/m^2
µL/(cm^2-s)	1.33	W/m^2
Torr-L/(cm^2-s)	1333.2	W/m^2
Dynamic viscosity		
poise	10	Pa-s
Newton-s/m^2	1	Pa-s
Kinematic viscosity		
centistoke	1	mm^2/s
Diffusion constant		
cm^2/s	0.0001	m^2/s
Heat conductivity		
watt-cm^{-1}-K^{-1}	100	J-s^{-1}-m^{-1}-K^{-1}
Specific heat		
cal-(g-mole)$^{-1}$-K^{-1}	4184	J-(kg-mole)$^{-1}$-K^{-1}
J-kg^{-1}-K^{-1}	*M*	J-(kg-mole)$^{-1}$-K^{-1}
BTU-lb^{-1}-°F^{-1}	4186*M*	J-(kg-mole)$^{-1}$-K^{-1}
Heat capacity		
cal-(g-mole)$^{-1}$	4184	J-(kg-mole)$^{-1}$
J/kg	*M*	J-(kg-mole)$^{-1}$
BTU/lb	2325.9*M*	J-(kg-mole)$^{-1}$
Energy, work or quantity of heat		
kW-h	3.6	MJ
kcal	4184	J
BTU	1055	J
ft-lb	1.356	J
To get conventional unit ←	**divide by ←**	**SI unit**

Manufactured in the United States of America.

Contact Us

Greene, Tweed Companies

Corporate Headquarters
Kulpsville, PA, USA
Tel: +1.215.256.9521
Tel: +1.800.220.4733
Fax: +1.215.256.0189

Sales Office
Santa Clara, CA, USA
Tel: +1.408.492.1155
Tel: +1.800.716.5316
Fax: +1.408.492.0050

Greene, Tweed & Co., Benelux B.V.
Halsteren, Netherlands
Tel: +31.0.164.612.123
Fax: +31.0.164.610.030

Greene, Tweed & Co., France S.A.
Cergy-Pontoise, France
Tel: +33.0.1.30.73.54.44
Fax: +33.0.1.30.73.45.75

Greene, Tweed & Co., GmbH
Hofheim am Taunus, Germany
Tel: +49.0.6192.929950
Fax: +49.0.6192.900316

Greene, Tweed & Co., Japan
Tokyo, Japan
Tel: +81.3.3454.1050
Fax: +81.3.3454.1040

Greene, Tweed & Co., Korea Ltd.
Seoul, Korea
Tel: +82.2.544.2077
Fax: +82.2.544.2070

Greene, Tweed & Co., Limited
Ruddington, Nottingham, England
Tel: +44.0.115.9315.777
Fax: +44.0.115.9315.888

Greene, Tweed & Co., Pte. Ltd.
Singapore
Tel: +65.6.481.2808
Fax: +65.6.481.7338

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