

SEMICONDUCTOR
SEAL COMPOUND
SELECTION GUIDE

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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.

Comparison of Seal Properties

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 (O₂) 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 hardware 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 ₄ F	E	E	E	E	E	E	E	E	E	G	G
Acetylene	C ₂ H ₂	E	E	E	E	E	E	E	E	E	E	E
Ammonia	NH ₃	E	E	E	E	E	E	E	E	E	P	P
Argon	Ar	E	E	E	E	E	E	E	E	E	E	E
Arsenic Chloride	AsCl	E	E	E	E	E	E	E	E	E	P	P
Arsenic Trichloride	AsCl ₃	E	E	E	E	E	E	E	E	E	P	P
Arsine	AsH ₃	E	E	E	E	E	E	E	E	E	F	F
Boron Tribromide	BBr ₃	E	E	E	E	E	E	E	E	E	E	E
Boron Trichloride	BCl ₃	G	G	G	G	G	G	G	G	G	E	E
Boron Trifluoride	BF ₃	G	G	G	G	G	G	G	G	G	E	E
Bromine	Br	E	E	E	E	E	E	E	E	E	E	E
Carbon Dioxide	CO ₂	E	E	E	E	E	E	E	E	E	G	G
Carbon Tetrachloride	CCl ₄	G	G	G	G	G	G	G	G	G	E	E
Carbon Tetrafluoride	CF ₄	G	G	G	G	G	G	G	G	G	E	E
Chlorine	Cl ₂	G	G	G	E	E	G	G	G	G	E	E
Chloropentafluoroethane (F-115)	C ₂ F ₅ Cl	G	G	G	G	G	G	G	G	G	E	E
Diborane	B ₂ H ₆	E	E	E	E	E	E	E	E	E	G	G
Dichlorodifluoromethane (F-12)	CCl ₂ F ₂	G	G	G	G	G	G	G	G	G	G	G
Dichlorosilane	SiH ₂ Cl ₂	E	E	E	E	E	E	E	E	E	G	G
Dimethylamine (DMA)	(CH ₃) ₂ NH	G	G	G	G	G	G	G	G	G	P	P
Disilane	Si ₂ H ₆	E	E	E	E	E	E	E	E	E	G	G
Difluoroethane (F-152A)	CH ₃ CHF ₂	G	G	G	G	G	G	G	G	G	P	P
Fluorine	F ₂	G	G	G	G	G	G	G	G	G	G	G
Fluoroform (F-23)	CHF ₃	E	E	E	E	E	E	E	E	E	P	P
Germanium Tetrahydride	GeH ₄	E	E	E	E	E	E	E	E	E	G	G
Helium	He	E	E	E	E	E	E	E	E	E	E	E
Hexachlorodisilane	Si ₂ Cl ₆	E	E	F	E	E	E	E	E	E	G	G
Hexafluoroethane (F-116)	C ₂ F ₆	G	G	G	G	G	G	G	G	G	G	G
Hydrogen	H ₂	E	E	E	E	E	E	E	E	E	E	E
Hydrogen Bromide	HBr	E	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 ₂ Se	E	E	E	E	E	E	E	E	F	F
Hydrogen Sulfide	H ₂ S	G	G	E	G	G	G	E	G	P	P
Methyl Chloride	CH ₃ Cl	E	E	E	E	E	E	E	E	E	E
Monomethylamine	CH ₅ N	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 ₂ O	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 ₃ F 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 ₂ H ₅) ₄ SiO 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 ₂ H ₃ Cl 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) ₃ N	G	G	G	G	G	G	G	G	P	P
Trisilane	Si ₃ H 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 ₃ COOH	F	F	F	F	F	F	F	F	F	G	G
Acetic Acid, glacial	CH ₃ COOH	P	P	F	E	E	F	F	F	F	P	P
Acetone	CH ₃ COCH ₃	E	E	E	E	E	E	E	E	E	P	P
Ammonium Fluoride (40%)	NH ₄ F	P	P	E	E	E	F	E	F	F	G	G
Ammonium Hydroxide (conc.)	NH ₄ OH	F	F	E	E	E	G	E	E	E	F	F
Aqua Regia	HNO ₃ :HCl	F	F	G	E	E	F	G	F	F	P	P
Buffered Oxide Etchants (BOE)	NH ₄ F:HF	P	P	E	E	E	F	E	F	F	G	G
Butanol	C ₄ H ₁₀ O	E	E	E	E	E	E	E	E	E	G	G
Butyl Acetate	CH ₃ COO(CH ₂) ₃ CH ₃	E	E	E	E	E	E	E	E	E	P	P
Carbon Tetrachloride	CCl ₄	G	G	G	G	G	G	G	G	G	G	G
Cellusolve Acetate	CH ₃ COOCH ₂ CH ₂ OCH ₂ CH ₃	E	E	E	E	E	E	E	E	E	P	P
Chromic Acid	CrO ₃ :(H ₂ CrO ₄)	P	P	E	E	E	F	E	P	P	G	G
Cyclohexane	C ₆ H ₁₂	E	E	E	E	E	E	E	E	E	G	G
Cyclohexanone	C ₆ H ₁₀ O	G	G	G	E	E	G	G	G	G	P	P
Deionized Water	H ₂ O	P	P	E	E	E	F	E	F	F	F	F
Dimethylsulfoxide (DMSO)	(CH ₃) ₂ SO	E	E	E	E	E	E	E	E	E	P	P
Ethylene Glycol Mono Methyl Ether Acetate (EGMEA)	CH ₃ CH ₂ OCH ₂ CH ₂ COOCH ₃	G	G	G	G	G	G	G	G	G	E	E
Ethylene Glycol Methyl Ether Acetate (EGMEEA)	CH ₃ COOCH ₂ CH ₂ OC ₂ H ₅	G	G	G	G	G	G	G	G	G	E	E
Ethanol	CH ₃ CH ₂ OH	E	E	E	E	E	E	E	E	E	G	G
Ethyl Acetate	CH ₃ COOC ₂ H ₅	E	E	E	E	E	E	E	E	E	P	P
Ethyl Lactate	CH ₃ CH ₂ OCOOC ₂ H ₅	E	E	E	E	E	E	E	E	E	P	P
Ethylene Glycol	CH ₂ OHCH ₂ OH	E	E	E	E	E	E	E	E	E	G	G
Freon TF	CCl ₂ FCClF ₂	P	P	P	P	P	P	P	P	P	G	G
Glycerol	C ₃ H ₅ (OH) ₃	E	E	E	E	E	E	E	E	E	E	E
Heptane	CH ₃ (CH ₂) ₅ CH ₃	E	E	E	E	E	E	E	E	E	G	G
Hexamethyldisilazane (HMDS)	(CH ₃) ₃ SiNHSi(CH ₃) ₃	E	E	E	E	E	E	E	E	E	P	P
Hexane	CH ₃ (CH ₂) ₄ CH ₃	E	E	E	E	E	E	E	E	E	G	G
Hydrochloric Acid (conc.)	HCl	P	P	E	E	E	F	E	F	F	G	G
Hydrofluoric Acid (49%)	HF	P	P	E	E	E	F	E	F	F	G	G
Hydrofluoric Acid (dilute)	HF	P	P	E	E	E	F	E	F	F	G	G
Hydrogen Peroxide (30%)	H ₂ O ₂	E	E	G	E	E	E	G	E	E	G	G
Isobutanol	C ₄ H ₁₀ O	E	E	E	E	E	E	E	E	E	G	G
Isopropanol (IPA)	CH ₃ CHOHCH ₃	E	E	E	E	E	E	E	E	E	G	G
Methanol	CH ₃ OH	E	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 ₃ COCH ₂ CH ₃	E	E	E	E	E	E	E	E	P	P
Methyl Isobutyl Ketone (MIBK)	(CH ₃) ₂ CHCH ₂ COCH ₃	E	E	E	E	E	E	E	E	P	P
Methylene Chloride	CH ₂ Cl 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 ₂ CH ₂ NH 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 ₃ OCH ₂ OCH ₂ CH ₂ OH	E	E	E	E	E	E	E	E	P	P
Neutral Oxide Etchants (NOE)	Ethylene Glycol/nNH ₄ F:H ₂ O:Surfactant	P	P	E	E	E	F	E	F	G	G
Ozonated Deionized Water	O ₃ :H ₂ O	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) ₃ CH ₃	E	E	E	E	E	E	E	E	G	G
P-Etch	HNO ₃ :HF:DI H ₂ O (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 ₃ PO ₄	P	P	E	E	E	F	E	F	G	G
Piranha	H ₂ SO ₄ :H ₂ O 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 ₃ CHOHCH ₂ OH	E	E	E	E	E	E	E	E	G	G
RCA Etch	H ₃ PO ₄ :CH ₃ CO ₂ H:HNO ₃ :DI H ₂ O (75:15:5:5)	P	P	E	E	E	F	E	F	G	G
SC1	NH ₄ OH:H ₂ O ₂ :DI H ₂ O	P	P	E	E	E	F	E	F	G	G
SC2	HCl:H ₂ O ₂ :DI H ₂ O	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 ₂ SO ₄	P	P	E	E	E	F	E	F	G	G
Tetrachloroethylene (Perchloroethylene)	C ₂ Cl ₄	E	E	E	E	E	E	E	E	E	E
Tetramethyl Ammonium Hydroxide (TMAH) 5%	(CH ₃) ₄ NOH	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 ₆ H ₅ CH ₃	E	E	E	E	E	E	E	E	G	G
Trichloroethane	C ₂ H ₃ Cl 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 ₁₃ SiC ₆ H 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 ₂ FCClF ₂	G	G	G	G	G	G	G	G	G	G
Xylene	C ₆ H 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 -cm/sec-cm ² -atm)	
	Helium	Oxygen
Silicone Rubber	251.7 x 10 ⁻⁸	214.5 x 10 ⁻⁸
Perfluoroelastomer	68.3 x 10 ⁻⁸	24.2 x 10 ⁻⁸
Fluoroelastomer	12.3 x 10 ⁻⁸	1.7 x 10 ⁻⁸
Butyl Rubber	5.8 x 10 ⁻⁸	0.9 x 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 x 10 ⁻⁵
Perfluoroelastomer	17.6 x 10 ⁻⁵
Fluoroelastomer	16.4 x 10 ⁻⁵
Butyl Rubber	15.1 x 10 ⁻⁵
Stainless Steel (ref.)	0.6 x 10 ⁻⁵

Effects of Available Compressive Force on Seal Design

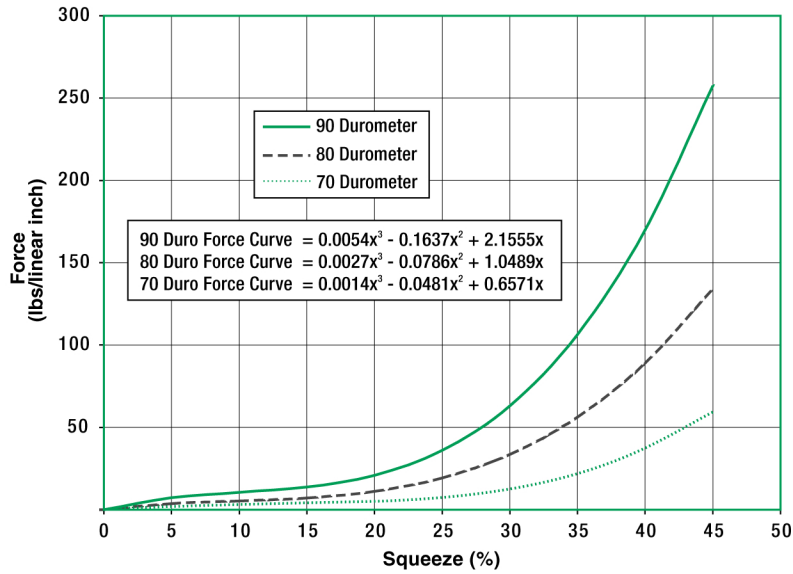
The compressive force required for an O-ring to effect a seal is as important as the seal's size, durometer and chemical compatibility. Inadequate squeeze on the cross-section of an O-ring reduces the sealing footprint and can cause failure. The following factors must be considered for optimum seal integrity:

- 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).

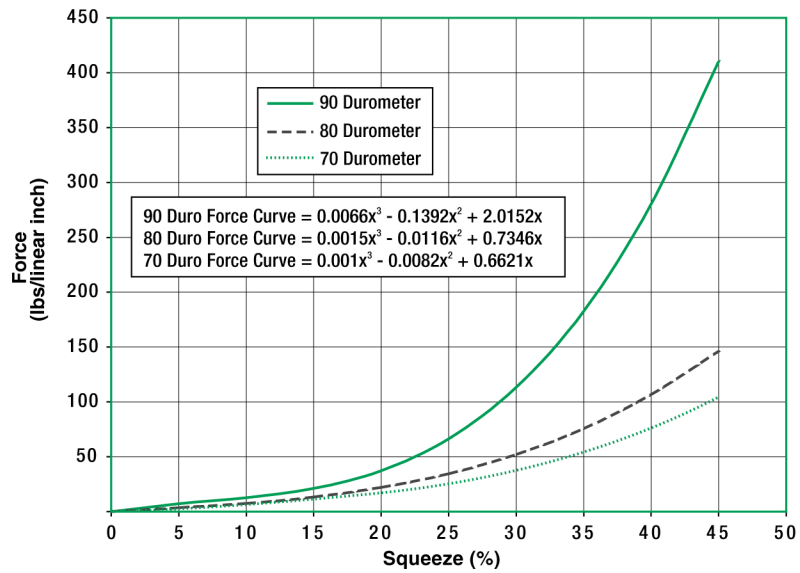
Average force curves approximate the force necessary to compress standard Chemraz® O-ring cross-sections at three hardness levels – 70, 80 and 90 Shore A, Hardness. The following graphs show the average O-ring compressive force curves for 0.070", 0.103", 0.139", 0.210" and 0.275" cross-sections. Please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

Average O-Ring Compressive Force

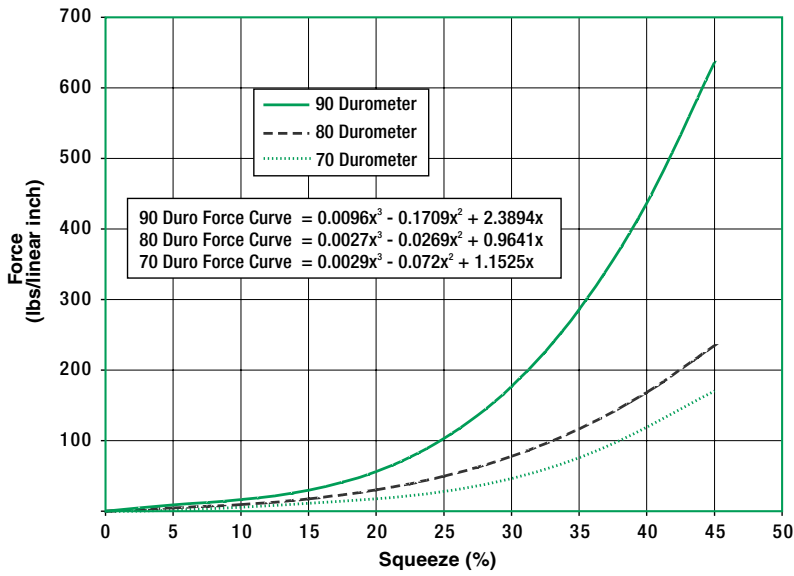
0.070" Cross-Section



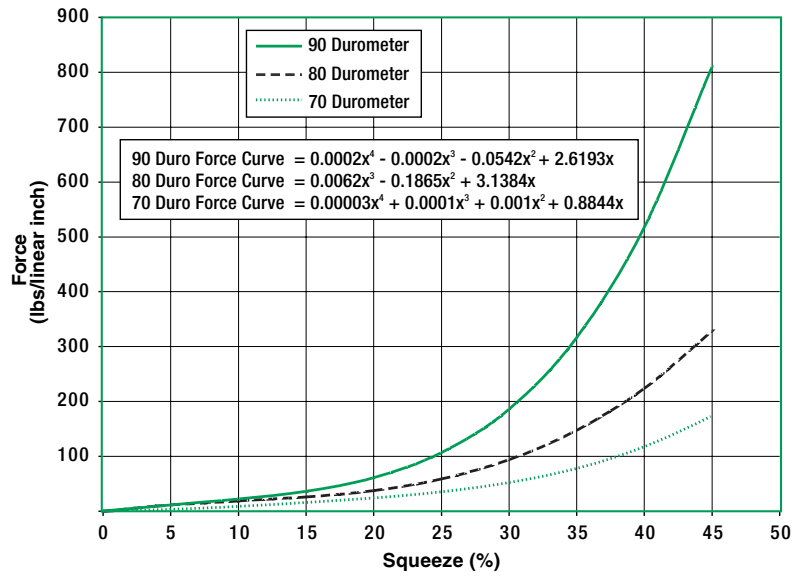
0.103" Cross-Section



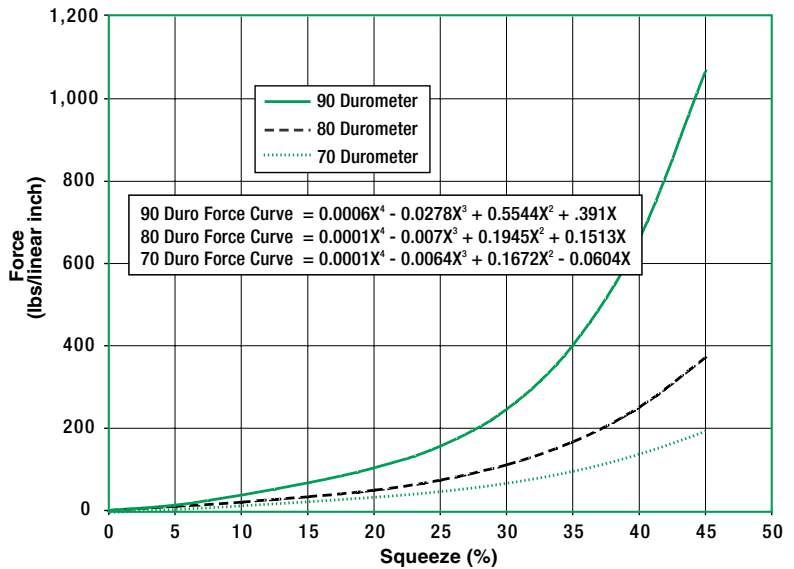
0.139" Cross-Section



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 and Systems

Seal Sizing

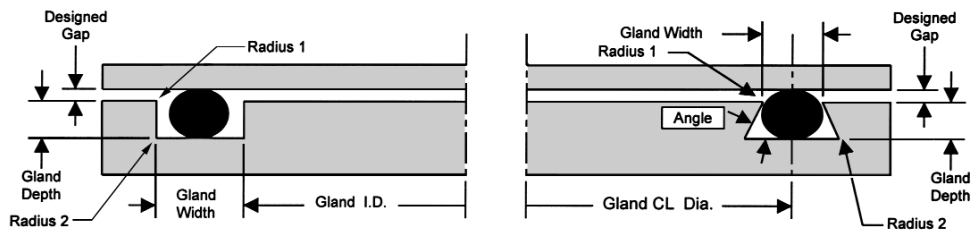
$$\text{Cross-Section Squeeze \%} = \left(\frac{\text{Seal Cross-Section} - \text{Gland Depth}}{\text{Seal Cross-Section}} \right) \times 100\%$$

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

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

Seal Systems

Static Face Sealing System



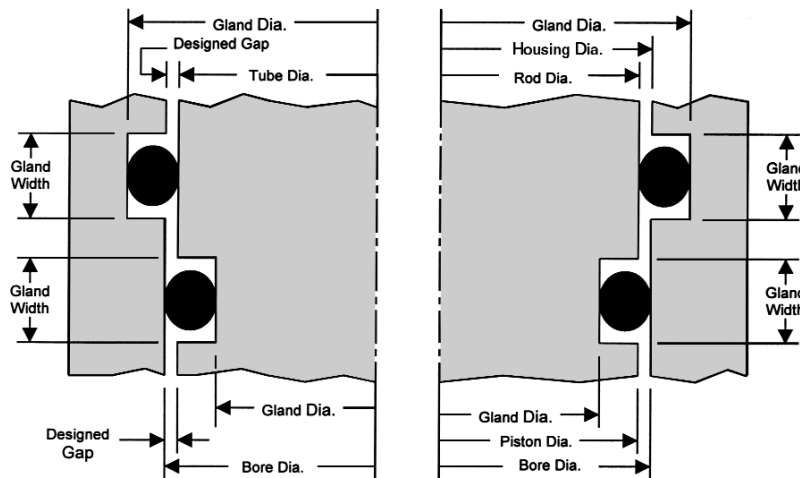
Rectangular Face Seal Gland

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

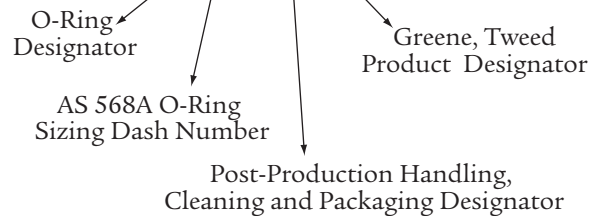
When ordering Greene, Tweed seals, please consult Greene, Tweed customer service or the *Right Seal Handbook* and follow the part number format listed below:

Standard O-Rings

9 XXX - XX XXX

Example:

9 214 - SD 592

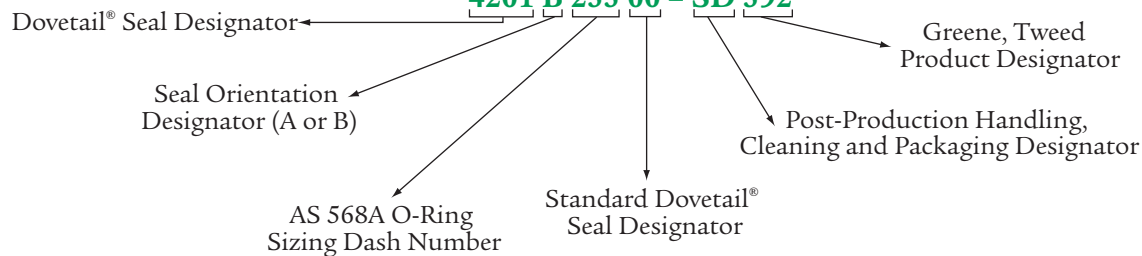


Dovetail® Seals

4201 X XXX 00 - XX XXX

Example:

4201 B 255 00 - SD 592

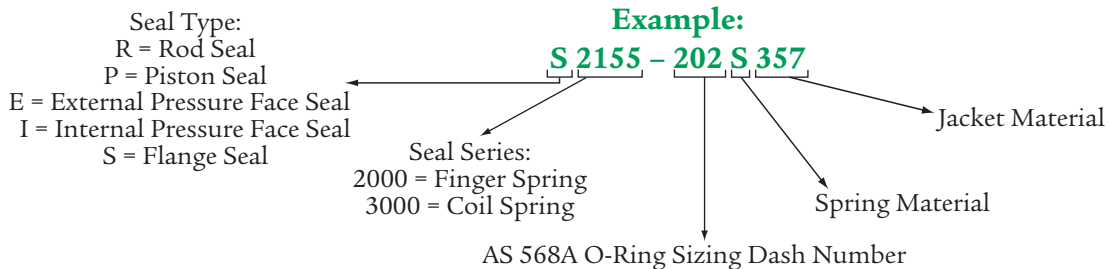


MSE Seals

X XXXX - XXX X XXX

Example:

S 2155 - 202 S 357



Constants and Units

Physical Constants		
k	Boltzmann's constant	1.3804×10^{-23} J/K
m_e	Rest mass of electron	9.108×10^{-31} kg
m_p	Rest mass of proton	1.672×10^{-27} kg
N_o	Avogadro's number	6.02252×10^{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	5.67×10^{-8} J-s ⁻¹ -m ⁻² -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 x 10 ⁹	Pa-L/s
molecules/s (at 0°C)	4 x 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	<i>M</i>	J-(kg-mole) ⁻¹ -K ⁻¹
BTU-lb ⁻¹ -°F ⁻¹	4186 <i>M</i>	J-(kg-mole) ⁻¹ -K ⁻¹
Heat capacity		
cal-(g-mole) ⁻¹	4184	J-(kg-mole) ⁻¹
J/kg	<i>M</i>	J-(kg-mole) ⁻¹
BTU/lb	2325.9 <i>M</i>	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

Statements and recommendations in this publication are based on our experience and knowledge of typical applications for these products and shall not constitute a guarantee or warranty of performance nor a modification or alteration of our standard warranty which shall be applicable to such products.

Prior to actual use it is recommended compatibility tests be run to determine suitability in a specific application. This is critical where failure could result in injury or damage. A regular program of inspection and replacement should be implemented. Greene, Tweed technical personnel are available to help with a recommendation.

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