



VACUUM
VACUUM GUIDE 3
SOME VACUUM MATERIALS

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Some Vacuum Materials

OUTGASSING RATES (AT ROOM TEMPERATURE)

MATERIAL	PREVIOUS TREATMENT	PUMPING TIME (hours)	OUTGASSING RATE AFTER PUMPING (mbar.l.s ⁻¹ .cm ²)
Steel	Non polished, slightly rusted	8	2.10 ⁻⁸
	Polished	8	2.10 ⁻⁹
Stainless Steel	Machined	5	2.10 ⁻⁹
	Alcohol cleaned	5	9.10 ⁻¹⁰
	Alcohol cleaned	24	2.10 ⁻¹⁰
	400°C baking	16	3.10 ⁻¹⁴
	Chemically cleaned	12	< 10 ⁻¹²
	300°C baking	24	10 ⁻¹²
Aluminum	Polished	5	7.10 ⁻¹⁰
	Alcohol cleaned	24	1.5.10 ⁻¹⁰
	400°C baking	16	2.10 ⁻¹⁴
Elastomer: - Viton - Viton - Viton - Teflon - Silicone - Neoprene	-	24	2.10 ⁻⁸
	4 h, 150°C baking	15	10 ⁻¹⁰
	16 h, 200°C baking	15	10 ⁻¹⁰
	-	48	3.5.10 ⁻¹⁰
	-	24	4.4.10 ⁻⁹
	-	24	5.4.10 ⁻⁸

SOME STANDARDS AND COMPOSITIONS FOR AUSTENITIC STAINLESS STEELS

AISI*	NF EN 10088-1		FRANCE	TYPICAL COMPOSITION %			
				C	Cr	Mo	Ni
301	1.4310	X10CrNi18-8	Z12CN18-09	0.05 - 0.15	16 - 19	< 0.8	6 - 9.5
304	1.4301	X5CrNi18-10	Z6CN18-09	< 0.07	17.0 - 19.5	-	8.0 - 10.5
304L	1.4306	X2CrNi19-11	Z3CN18-10	< 0.03	18.0 - 20.0	-	10 - 12
304L	1.4307	X2CrNi18-9	Z3CN18-09	< 0.03	17.5 - 19.5	-	8 - 10
316	1.4401	X5CrNiMo17-12-2	Z6CND17-11	< 0.07	16.5 - 18.5	2 - 2.5	10 - 12
316L	1.4404	X2CrNiMo17-12-2	Z2CND17-12	< 0.03	16.5 - 18.5	2 - 2.5	11 - 13
316L	1.4435	X2CrNiMo18-14-3	Z3CND18-14-03	< 0.03	17 - 19	2 - 3	12.5 - 14
316LN	1.4429	X2CrNiMoN17-13-3	Z2CND17-13	< 0.03	16.5 - 18.5	2 - 3	12 - 14
316Ti	1.4571	X6CrNiMoTi17-12-2	Z6CNDT17-12	< 0.06	16.5 - 18.5	2.5 - 3	11 - 13
321	1.4541	X6CrNiTi18-10	Z6CNT18-10	< 0.06	17 - 19	-	9 - 12

*AISI: American Iron Steel Institute

PROPERTIES OF COPPER

**OFHC: Oxygen Free High Conductivity

PURITY	99.95% Cu	99.99% Cu
Alloy Name	OFHC**	Certified OFHC*
French Name	Cu-c1	Cu-c2
ISO CEN	Cu-OF	Cu-OFE
USA	C10200	C10100
Density	8.94 g.cm ⁻³	8.94 g/cm ³
Thermal conductivity (at 20°C)	389 W.m ⁻¹ .K ⁻¹	392 W.m ⁻¹ .K ⁻¹
Electrical conductivity (at 20°C, % IACS)	100	101
Resistivity (at 20°C)	1.7.10 ⁻⁸ Ω.m	1.7.10 ⁻⁸ Ω.m

SOME ELASTOMERS AND PLASTICS PROPERTIES

MATERIAL NAME	CHEMICAL NAME	COLOUR	HARDNESS SHORE A	TEMPERATURE RANGE	TENSILE STRENGTH AT BREAK
Viton FPM FKM	Fluorocarbone Vynilidene-fluoridehexafluoropropene	Black Green	65-95	-20°C to +200°C	20 MPa
Nitrile Buna N Perbunan NBR	Butadiene acrylonitrile	Black	30-90	-20°C to +120°C	27 Mpa
EPDM	Ethylene propylene diene monomer	Black	40-90	-40°C to +140°C	25 MPa
Silicone MVQ	Polysiloxane	Brick red Yellow	40-80	-90°C to 200°C	10 MPa
Kalrez Chemraz FFKM	Perfluoroelastomers	Black	65-95	-10°C to 300°C	15 Mpa
Neoprene CR	Chloroprene rubber	Black	30-90	-40°C to 105°C	25 Mpa
Teflon PTFE	Polytetrafluoroethylene	White	50-65 (shore D)	-150 to +250 °C	10-40 Mpa
PEEK	Polyether ether ketone	Black	85-90 (shore D)	-50°C to 250°C	90-110 Mpa

SOME GLASS PROPERTIES

Chemical compositions

	SiO ₂	B ₂ O ₃	Na ₂ O + K ₂ O	Al ₂ O ₃
Duran/Pyrex	~ 81 %	~ 13 %	~ 4 %	~ 2.3 %
Kodial	~ 68 %	~ 18 %	~ 10 %	~ 3 %

Properties

	DURAN / PYREX	KODIAL	QUARTZ
Average linear expansion coefficient (20 - 300°C, ISO 7991)	$3.3 \cdot 10^{-6} \text{ } ^\circ\text{C}^{-1}$	$5.15 \cdot 10^{-6} \text{ } ^\circ\text{C}^{-1}$	$5.5 \cdot 10^{-7} \text{ } ^\circ\text{C}^{-1}$
Refractive index ($\lambda = 587.6 \text{ nm}$)	1.473	1.487	1.4585
Density (at 20°C)	2.23 g.cm^{-3}	2.29 g.cm^{-3}	2.2 g.cm^{-3}
Thermal conductivity (20 - 100 °C)	$1.16 \text{ W.m}^{-1}\text{.K}^{-1}$	$1.19 \text{ W.m}^{-1}\text{.K}^{-1}$	$1.4 \text{ W.m}^{-1}\text{.K}^{-1}$
VISCOSITY TEMPERATURES			
Strain point (lower cooling temperature, $10^{14.7} \text{ dPa.s}$)	510°C	472°C	1070°C
Annealing point (upper cooling point, 10^{13} dPa.s)	560°C	512°C	1140°C
Softening temperature ($10^{7.5} \text{ dPa.s}$)	820°C	718°C	1665°C
Working point (processing temperature, 10^4 dPa.s)	1252°C	1058	1000°C
MECHANICAL PROPERTIES			
Elasticity modulus (Young's modulus)	$64 \cdot 10^3 \text{ MPa}$	$64 \cdot 10^3 \text{ MPa}$	$70 \cdot 10^3 \text{ MPa}$
Poisson's ratio	0.20	2.21	0.17
ELECTRICAL PROPERTIES			
Log_{10} of volume resistivity	13-15 $\Omega\text{.cm}$ (at 20°C)	10.3 $\Omega\text{.cm}$ (at 250°C)	16 $\Omega\text{.cm}$ (at 20°C)
Dielectric constant (20°C, 1 MHz)	4.6	5.7	3.75
Dielectric loss factor $\tan \delta$	$37 \cdot 10^{-4}$	$27 \cdot 10^{-4}$	$< 4 \cdot 10^{-4}$



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