PRINCETON UNIVERSITY
PLASMA PHYSICS LABORATORY
JAMES FORRESTAL CAMPUS
P.O. BOX 451 PRINCETON, NJ

ENGINEERING TECHNICAL MEMORANDUM

PPL
PREFIX: ETM | DOCUMENT NO.: 82-001 | REV: A
ISSUE DATE: 15 FEB 82 | SHEET NO.: 1 OF 22

TITLE

A COMPILATION OF OUTGASSING DATA ON VACUUM MATERIALS

PREPARED: E. A. MOSHEY
APPROVED: E. A. Moshey
APPROVED:

1.0 SCOPE

1.1 The outgassing data contained herein is intended for reference as an aid to engineers and researchers working with vacuum systems and in particular, TFTR related projects.

The data has been compiled from many sources which are listed in the Bibliography section.

1.2 When considering these materials for TFTR and TFTR diagnostics special attention must also be given to the effect that radiation and high temperature may have on altering the outgassing rate of a material.

2.0 APPLICABLE DOCUMENTS

2.1 Please refer to the bibliography attached to this report for additional information on the materials cited.

3.0 DEFINITIONS

3.1 A materials manufacturer's code list is attached to this report.

3.2 TFTR - Tokamak Fusion Test Reactor.

3.3 PPPL - Princeton Plasma Physics Laboratory

3.4 VMC - Vacuum Materials Committee (at PPPL).

3.5 TBS - To Be Supplied.

4.0 ABSTRACT

4.1 DATA PRESENTATION - The outgassing rates of materials have been organized into sections as indicated in the Table of Contents. Table - I defines the preferred outgassing rates for approved materials for TFTR in accordance with the three VMC categories, i.e.; Category - I Materials - Approved for TFTR; Category- II Materials-Approved for use only in certain locations in the vacuum vessel; Category - III Materials-New or innovative materials to be approved on a case by case basis. Tables for various classifications of materials follow Table - I. An alphabetical summary table of all materials concludes the listing.

As new or additional data becomes available it will be added to the compilation and periodically this report will be revised.

4.2 TFTR VACUUM MATERIALS COMMITTEE REQUIREMENTS - The TFTR Vacuum Materials Committee has arrived at a definition of vacuum appendages to the tokamak which gives diagnostic developers design control with less need to get approval from the Committee.

For a single appendage that is connected to the torus through one or more ducts, the principal vacuum requirements are: (a) either the base pressure achieved in the appendage under test must not exceed 10^{-8} torr, or the total throughput at the torus connection ports must not exceed 10^{-6} torr-liters/sec of residual non-hydrogenious gas under operating conditions; and (b) the total leak rate of atmospheric air into the appendage vacuum enclosure and ducts must not exceed 10^{-9} torr-liters/sec (the leak rate requirement does not apply to neutral beams and the diagnostic neutral beam, which have elastomeric seals in the vacuum boundary).

4.3 PRECAUTION- The outgassing rate achieved is a function of pumping time, pressure and pump speed. If vacuum is broken many of the materials will adsorb certain gases or water vapor. To achieve the outgassing rates listed it may be necessary to rebake and pump for at least 24 hours to allow the gas to desorb.

5.0 TABLE OF CONTENTS

MATERIAL	OUTGASSING RATE*	TEMP. (^{o}C)	MFGR.	REF.	NOTES
CATEGORY - I					
ALUMINA	$1x10^{-8}$ to 10^{-9}	25		16	Clean, after a few hours of pumping.
ALUMINA	$1x10^{-14}$ to 10^{-15}	25		16	24 hr. bake @400^{o}C
ALUMINUM - 6061	2.5×10^{-8}			5	10 hrs- -vac.
ALUMINUM - 6061-T4	1×10^{-14}	20		12	cleaned & 24hrs@200^{o}C
COPPER OFHC (as rec'd)	3×10^{-10}			5	unbaked 40hrs-vac
COPPER OFHC (as rec'd surf. removed)	4×10^{-11}			5	unbaked 40hrs-vac
GLASS	$1x10^{-8}$ to 10^{-9}	25		16	Clean-after a few hrs pump.
GLASS	$1x10^{-14}$ to 10^{-15}	25		16	24 hr. bake @ 400^{o} C.
INCONEL 625	2×10^{-9}			8	20 hrs-vac
INCONEL 625	5.5×10^{-13}			8	24hrs@500^{o}C &20hrs-vac
MACOR	TBS #				#-No specific data to date expect similar to glass
QUARTZ	TBS #				
STAINLESS STEEL-304 (Degreased)	8×10^{-11}			5	unbaked 40hrs-vac
STAINLESS STEEL-304 (Varian Std. clean)	4×10^{-12}			5	baked 150^{o}C 24hrs-vac
CATEGORY II					
KAPTON (H-FILM)	1×10^{-11}	25-150	DUP	2	
KAPTON (H-FILM)	8×10^{-7}	300	DUP	Gen. Atomic	
POLYIMIDE SP-1	9×10^{-9}	250	DUP	Gen. Atomic	
TITANIUM 6AL4V	1.8×10^{-9}	-	-	7	
VITON E60C	1×10^{-7}	225	DUP	2	
VITON E60C	2×10^{-9}	144	DUP	2	
VITON E60C	6×10^{-10}	95	DUP	2	
VITON - A	1×10^{-7}	200	DUP	1	baked 12hrs@200^{o}C

*Torr-liter-sec^{-1}cm^{-2}

MATERIAL	OUTGASSING RATE *	TEMP (^{o}C)	MFGR	REF	NOTES
CATEGORY II Con't.					
VITON - A	2×10^{-9}	100	DUP	1	baked 12hrs@200^{o}C
CATEGORY III					
NONE					

*Torr-liter-sec^{-1}cm^{-2}

MATERIAL	OUTGASSING RATE *	TEMP (°C)	MFGR	REF	NOTES
ALUMINUM 1100-0 (Nitric-sulfuric Dip)	2.9×10^{-10}	25	-	3	
ALUMINUM 6061-T6 (Nitric-sulfuric Dip)	2.8×10^{-10}	25	-	3	
ALUMINUM 1100-0 Black Anodized	8.2×10^{-8}	25	-	3	
ALUMINUM 6061-T6	2.5×10^{-8}	-	-	5	after 10 hrs
ALUMINUM ANODIZED	1.0×10^{-7} 3.0×10^{-9}	-	-	5	after 10 hrs after 40 hrs
ALUMINUM CLEAN & SOME OXIDE	1.0×10^{-9} 3.0×10^{-10}	-	-	5	after 10 hrs after 40 hrs
ALUMINUM 2024	3.5×10^{-8}	-	-	7	
ALUMINUM 6061-T4	1×10^{-14}	20	-	12	cleaned surf. & 24hrs @200°C.
COPPER OFHC (Nitric-sulfuric Dip)	3.4×10^{-11}	25	-	3	
COPPER "RAW"	5×10^{-9}	-	-	5	after 48 hrs
COPPER "RAW" OFHC	4×10^{-9}	-	-	5	after 30 hrs
COPPER POLISHED	6.5×10^{-10}	-	-	5	after 48 hrs
COPPER OFHC POLISHED	3.5×10^{-10}	-	-	5	after 48 hrs
COPPER OFHC as rec'd surf. removed	1.5×10^{-10} 4×10^{-11}	-	-	5	after 10 hrs after 40 hrs
COPPER OFHC as rec'd	1×10^{-9} 3×10^{-10}	-	-	5	after 10 hrs after 40 hrs
COPPER AS REC'D	4×10^{-9} 8×10^{-10}	-	-	5	after 10 hrs after 40 hrs
COPPER ON STAINLESS STEEL HI-TEMP FLUX BRAZED	1.3×10^{-8}	25	-	3	
ELECTROLESS NICKEL OVER 1018 CARBON STEEL	4.8×10^{-10}	25	-	3	

* Torr-liter-$sec^{-1}cm^{-2}$

MATERIAL	OUTGASSING RATE *	TEMP (^{o}C)	MFGR	REF	NOTES
HASTELLOY - X	2.5×10^{-10}	-	-	8	20 hrs
HASTELLOY - X	2.7×10^{-13}	-	-	8	20hrs &500^{o}C bake
INCONEL - 625	2×10^{-9}	-	-	8	20 hrs
INCONEL - 625	5.5×10^{-13}	-	-	8	20hrs & 500^{o}C bake
MAGNESIUM ALLOY (4hrs in vac)	1×10^{-7}	-	-	9	chromated DTD 911 C Bath-V
MOLYBDENUM	3.5×10^{-11}	-	-	8	20 hrs
MOLYBDENUM	3.8×10^{-13}	-	-	8	20hrs & 500^{o}C bake
MU - METAL LAMIN. CLEANED (NET AREA)	6.9×10^{-9}	25	-	3	
STAINLESS STEEL - 304L	9.8×10^{-10}	-	-	8	20 hrs
STAINLESS STEEL - 304L	5×10^{-12}	25	-	8	20hrs & 500^{o}C bake
STAINLESS STEEL 304 BEAD BLASTED	1.5×10^{-9}	25	-	3	
STAINLESS STEEL 304 SAND BLASTED	6.7×10^{-10}	25	-	3	
STAINLESS STEEL - 304 ELECTRO-POLISHED	2.5×10^{-10}	-	-	5	after 24 hrs
STAINLESS STEEL - 304 DEGREASED	2.5×10^{-10} 8×10^{-11}	-	-	5	after 10 hrs after 40 hrs
STAINLESS STEEL 304	4.0×10^{-12}	150	-	5	baked: 150^{o}C/24 hrs
DEGREASED & BAKED	4.0×10^{-12}	300			300^{o}C/25 hrs
STAINLESS STEEL - 304 VARIAN STD CLEANING	4.0×10^{-12}	150	VAR	5	150^{o}C/24 hrs
STAINLESS STEEL - 304	1.5×10^{-10}	-	VAR	5	unbaked 10 hrs
VARIAN STD CLEANING	4.0×10^{-11}				unbaked 40 hrs
STAINLESS STEEL U15C LOW C 300 SERIES	1.0×10^{-12}	300	-	6	baked 300^{o}C/24hrs
STAINLESS STEEL 321	1.4×10^{-9}	-	-	7	

*Torr-liter-sec^{-1}cm^{-2}

MATERIAL	OUTGASSING RATE *	TEMP (^{o}C)	MFGR	REF	NOTES
STEEL - 4750 MACHINED & GROUND	4.5×10^{-10}	25	ALC	3	
STEEL - 4750 AS ROLLED	5.7×10^{-9}	25	ALC	3	
TITANIUM 6AL 4V	1.8×10^{-9}	-	-	7	

MATERIAL	OUTGASSING RATE *	TEMP (^{o}C)	MFGR	REF	NOTES
EPOXY GLASS LAM. G-10	1.2×10^{-7}	25	-	3	
KALREZ	6×10^{-10}	145	DUP	2	
KALREZ	1×10^{-10}	170	DUP	2	
KAPTON FILM(TYPE-H)	8×10^{-7}	300	DUP	General Atomic	
KAPTON FILM(TYPE-H)	1×10^{-6}	350	DUP	"	
KAPTON FILM(TYPE-H)	1×10^{-11}	25-150	DUP	2	
KAPTON FILM(TYPE-H)	1.6×10^{-10}	190	DUP	2	
KEL-F(Chloro fluoro-carbon)	4×10^{-8}	-	-	13	1 hr
KEL-F(Chloro fluoro-carbon)	3.5×10^{-10}	-	-	13	baked
LEXAN (Polycarbonate)	3.9×10^{-7}	-	-	10	4 hrs
MYLAR FILM PETP	4×10^{-7}	-	DUP	7	
MYLAR	4×10^{-7}	-	-	9	
NITRILE (Buna-N)	4×10^{-6}	-	-	10	4hrs@100^{o}C & 10hrs vac
NYLON 66 & MbS_2	6×10^{-8}	-	-	9	4 hrs
PHENOLIC INSULATOR	6.9×10^{-7}	25	ABR	3	unbaked
PHENOLIC INSULATOR	1.8×10^{-7}	25	ABR	3	vac baked 24hrs/125^{o}C
POLYETHYLENE	1.1×10^{-7}	-	-	10	4 hrs
POLYIMIDE	8×10^{-7}	-	-	13	1 hr
POLIMIDE	3×10^{-11}	-	-	13	baked
POLYIMIDE SP-1	9×10^{-9}	250	DUP	General-Atomic & VMC File	
" "	8×10^{-8}	300	DUP	"	" "
" "	6.5×10^{-7}	350	DUP	"	" "
" "	5.2×10^{-6}	400	DUP	"	" "

* (Torr-liter-sec^{-1}cm^{-2})

MATERIAL	OUTGASSING RATE *	TEMP (^{o}C)	MFGR	REF	NOTES
POLYIMIDE (Probably SP-1)	4.5×10^{-9}	100	DUP	1	
" "	2.7×10^{-8}	150	DUP	1	
" "	1.3×10^{-7}	200	DUP	1	
" "	7×10^{-7}	250	DUP	1	
POLYIMIDE PMR-15 (Fiberglass Reinforced)	2.5×10^{-7}	300	-	Grumman	
" "	5.5×10^{-6}	350	-	"	
POLYURETHANE	5×10^{-7}	-	-	13	unbaked
SILASTIC 55-74	6×10^{-7}	-	-	10	4 hrs
SILICONE RUBBER	2×10^{-6}	-	-	10	4 hrs
TEFLON (PTFE)	1.5×10^{-7}	-	-	9	4 hrs
" "	7.5×10^{-6}	-	-	10	4 hrs
TEFLON PTFE (wire sleeving)	2.5×10^{-8}	-	DUP	7	
VITON-A	2.3×10^{-7}	-	-	9	4 hrs & 24hrs@200^{o}C
VITON - E60C	6×10^{-10}	95	DUP	2	
" "	2×10^{-9}	144	DUP	2	
" "	1×10^{-8}	170	DUP	2	
" "	1×10^{-7}	225	DUP	2	
VITON A	5×10^{-11}	25	DUP	1	after bake 12hrs/200^{o}C
"	2×10^{-9}	100	DUP	1	" "
"	1×10^{-7}	200	DUP	1	" "
VITON A	$\sim 10^{-7}$	-	DUP	7	

* (Torr-liter-sec^{-1}cm^{-2})

MATERIAL	OUTGASSING RATE *	TEMP (^{o}C)	MFGR	REF	NOTES
EPOXY, ARALDITE AV100/AV100	$\sim 10^{-6}$	-	CIB	7	
EPOXY ARALDITE - D	1.2×10^{-8}	-	-	9	4 hrs
TORR-SEAL	1×10^{-5}	25	VAR	VMC File	1 hr
" "	7×10^{-7}	25	VAR	"	4 hrs
" "	8×10^{-6}	135	VAR	"	
VAC-SEAL	2×10^{-8}	-	PEC	"	
ACHMEX X7552 EPOXY	6×10^{-9}			14	50hr-vac&1hr@70^{o}C
EPICOAT 815 EPOXY	2.5×10^{-7}			14	60hr-vac&5hrs@95^{o}C
"	6×10^{-8}				250hrs-vac &5hrs@95^{o}C

* (Torr-liter-sec^{-1}cm^{-2})

MATERIALS	OUTGASSING RATE *	TEMP (^{o}C)	MFGR.	REF.	NOTES
	WEIGHT LOSS:				
BRAYCOTE 3L38RP GREASE	1.977×10^{-2} g/cm^2	125	BOC	VMC	as rec'd
" "	1.41×10^{-3} g/cm^2	125	BOC	VMC	vac. baked

* (torr-liter-sec^{-1}cm^{-2})

MATERIALS	OUTGASSING RATE *	TEMP (^{o}C)	MFGR.	REF.	NOTES
NO DATA AVAILABLE AS OF THIS ISSUE					

*(Torr-liter-sec^{-1}cm^{-2})

MATERIALS	OUTGASSING RATE *	TEMP (^{o}C)	MFGR.	REF.	NOTES
ALUMINA	$1x10^{-8}$ to 10^{-9}	25		16	Clean, after a few hrs pump.
ALUMINA	$1x10^{-14}$ to 10^{-15}	25		16	24 hrs bake @ 400^{o}C
BLACK PAINT, SPEREX ON IRRIDITED ALUM. ALLOY 1100-0	7.6×10^{-9}	25	SPX	3	2nd pump down
GLASS	$1x10^{-8}$ to 10^{-9}	25		16	Clean, after a few hrs pump.
GLASS	$1x10^{-14}$ to 10^{-15}	25		16	24 hr. bake @ 400^{o}C.
K-RAMIC (Silica-chrome-alumina coating)	2×10^{-9}	25	-	11	unbaked
" "	7×10^{-11}		-	11	24hrs @100^{o}C
MACOR	TBS				
PYROLYTIC GRAPHITE	1.5×10^{-10}	25	-	8	20 hrs
" "	9.8×10^{-13}	25	-	8	20hrs & 500^{o}C bake
QUARTZ	TBS				
STEATITE	4×10^{-8}	20	-	15	after 3 hrs of pumping

*(Torr-liter-sec^{-1}cm^{-2})

MATERIALS	OUTGASSING RATE *	TEMP (^{o}C)	MFGR.	REF.	NOTES
ALUMINA	$1x10^{-8}$ to 10^{-9}	25		16	Clean, after a few hr. pump.
ALUMINA	$1x10^{-14}$ to 10^{-15}	25		16	24 hr. @ 400^{o}C.
ALUMINUM - 6061-T6	2.5×10^{-8}	-	-	5	10 hrs - vac
ALUMINUM -6061-T4	1×10^{-14}	20	-	12	cleaned & 24hrs@200^{o}C
ALUMINUM 1100-0 (Nitric-sulfuric Dip)	2.9×10^{-10}	25	-	3	
ALUMINUM 6061-T6 (Nitric-sulfuric Dip)	2.8×10^{-10}	25	-	3	
ALUMINUM 1100-0 Black Anodized	8.2×10^{-8}	25	-	3	
ALUMINUM 6061-T6	2.5×10^{-8}	-	-	5	after 10 hrs
ALUMINUM ANODIZED	1.0×10^{-7}	-	-	5	after 10 hrs
	3.0×10^{-9}				after 40 hrs
ALUMINUM CLEAN & SOME OXIDE	1.0×10^{-9}	-	-		after 10 hrs
	3.0×10^{-10}				after 40 hrs
ALUMINUM 2024	3.5×10^{-8}	-	-	7	
BLACK PAINT, SPEREX ON IRRIDITED ALUM. ALLOY 1100-0	7.6×10^{-9}	25	SPX	3	2nd pump down
BRAYCOTE 3L38RP	$1.977x10^{-2}$ g/cm^{2}	125	BOC	VMC	as rec'd
GREASE	$1.41x10^{-3}$ g/cm^{2}	125	BOC	VMC	vac. baked
COPPER OFHC (Nitric-sulfuric Dip)	3.4×10^{-11}	25	-	3	
COPPER "RAW"	5×10^{-9}	-	-	5	after 48 hrs
COPPER "RAW" OFHC	4×10^{-9}	-	-	5	after 30 hrs

*(Torr-liter-sec^{-1}cm^{-2})

MATERIALS	OUTGASSING RATE *	TEMP (^{o}C)	MFGR.	REF.	NOTES
COPPER POLISHED	6.5×10^{-10}	-	-	5	after 48 hrs
COPPER OFHC POLISHED	3.5×10^{-10}	-	-	5	after 48 hrs
COPPER OFHC	1.5×10^{-10}	-	-	5	after 10 hrs
as rec'd surf. removed	4×10^{-11}	-	-	5	after 40 hrs
COPPER OFHC	1×10^{-9}	-	-	5	after 10 hrs
as rec'd	3×10^{-10}				after 40 hrs
COPPER AS REC'D	4×10^{-9}	-	-	5	after 10 hrs
	8×10^{-10}				after 40 hrs
COPPER ON STAINLESS STEEL HI-TEMP FLUX BRAZED	1.3×10^{-8}	25	-	3	
ELECTROLESS NICKEL OVER 1018 CARBON STEEL	4.8×10^{-10}	25	-	3	
EPOXY, ARALDITE AV100/HV100	$\sim 10^{-6}$	-	CIB	7	
EPOXY ARALDITE - D	1.2×10^{-8}	-	-	9	4 hrs
EPOXY GLASS LAM. G-10	1.2×10^{-7}	25	-	3	
GLASS	1×10^{-8} to 10^{-9}	25		16	Clean, after a few hr. pump.
GLASS	1×10^{-14} to 10^{-15}	25		16	24 hrs @ 400^{o}C.
HASTELLOY - X	2.5×10^{-10}	-	-	8	20 hrs
HASTELLOY - X	2.7×10^{-13}	-	-	8	20hrs & 500^{o}C bake
INCONEL - 625	2×10^{-9}	-	-	8	20 hrs
INCONEL - 625	5.5×10^{-13}	-	-	8	20 hrs & 500^{o}C bake
K-RAMIC (Silica-chrome-alumina coating)	2×10^{-9}	25	-	11	unbaked
" "	7×10^{-11}	-	-	11	24 hrs @100^{o}C
KALREZ	6×10^{-10}	145	DUP	2	

*(Torr-liter-sec^{-1}cm^{-2})

MATERIALS	OUTGASSING RATE *	TEMP (^{o}C)	MFGR	REF	NOTES
KALREZ	1×10^{-10}	170	DUP	2	
KAPTON FILM(TYPE-H)	8×10^{-7}	300	DUP	General	
KAPTON FILM(TYPE-H)	1×10^{-6}	350	DUP	Atomic	
KAPTON FILM(TYPE-H)	1×10^{-11}	25-150	DUP	2	
KAPTON FILM (TYPE-H)	1.6×10^{-10}	190	DUP	2	
KEL-F(Chloro-fluoro-carbon)	4×10^{-8}	-	-	13	1 hr
" "	3.5×10^{-10}	-	-	13	baked
LEXAN (Polycarbonate)	3.9×10^{-7}	-	-	10	4 hrs
MACOR	TBS				
MAGNESIUM ALLOY (4hrs in vac)	1×10^{-7}	-	-	9	chromated DTD 911 C Bath-V
MOLYBDENUM	3.5×10^{-11}	-	-	8	20 hrs
" "	3.8×10^{-13}	-	-	8	20 hrs &500^{o}C bake
MU METAL LAMIN. CLEANED (NET AREA)	6.9×10^{-9}	25	-	3	
MYLAR FILM PETP	4×10^{-7}	-	DUP	7	
MYLAR	4×10^{-7}	-	-	9	
NITRILE (Buna-N)	4×10^{-6}	-	-	10	4hrs @100^{o}C & 10 hrs vac
NYLON 66 & MbS_2	6×10^{-8}	-	-	9	4 hrs
PHENOLIC INSULATOR	6.9×10^{-7}	25	ABR	3	unbaked
PHENOLIC INSULATOR	1.8×10^{-7}	25	ABR	3	vac baked 24hrs/125^{o}C
POLYETHYLENE	1.1×10^{-7}	-	-	10	4 hrs
POLYIMIDE	8×10^{-7}	-	-	13	1 hr
POLYIMIDE	3×10^{-11}	-	-	13	baked
POLYIMIDE SP-1	9×10^{-9}	250	DUP	General-Atomic & VMC File	

*(Torr-liter-sec^{-1}cm^{-2})

MATERIALS	OUTGASSING RATE *	TEMP (^{o}C)	MFGR	REF	NOTES
POLYIMIDE SP-1	8×10^{-8}	300	DUP	General	Atomic & VMC File
" "	6.5×10^{-7}	350	DUP	"	" "
" "	5.2×10^{-6}	400	DUP	"	" "
POLYIMIDE (Probably SP-1)	4.5×10^{-9}	100	DUP	1	
" "	2.7×10^{-8}	150	DUP	1	
" "	1.3×10^{-7}	200	DUP	1	
" "	7×10^{-7}	250	DUP	1	
POLYIMIDE PMR-15 (Fiberglass Reinforced)	2.5×10^{-7}	300	-	Grumman	
" "	5.5×10^{-6}	350	-	VMC	
POLYIMIDE SP-1	9×10^{-9}	250	DUP	Gen. Atomic	
POLYURETHANE	5×10^{-7}	-	-	13	unbaked
PYROLYTIC GRAPHITE	1.5×10^{-10}	25	-	8	20 hrs
" "	9.8×10^{-13}	25	-	8	20hrs & 500^{o}C bake
QUARTZ	TBS				
SILASTIC 55-74	6×10^{-7}	-	-	10	4 hrs
SILICONE RUBBER	2×10^{-6}	-	-	10	4 hrs
STAINLESS STEEL 304L	9.8×10^{-10}	-	-	8	20 hrs
" " "	5×10^{-12}	25	-	8	20hrs & 500^{o}C bake
STAINLESS STEEL 304 BEAD BLASTED	1.5×10^{-9}	25	-	3	
STAINLESS STEEL 304 SAND BLASTED	6.7×10^{-10}	25	-	3	
STAINLESS STEEL 304 ELECTRO-POLISHED	2.5×10^{-10}	-	-	5	after 24 hrs
STEATITE	4×10^{-8}	20	-	15	3 hrs in vacuum

*(Torr-liter-sec^{-1}cm^{-2})

MATERIALS	OUTGASSING RATE *	TEMP (^{o}C)	MFGR.	REF	NOTES
STAINLESS STEEL - 304 DEGREASED	2.5×10^{-10}	-	-	5	after 10 hrs
	8×10^{-11}				after 40 hrs
STAINLESS STEEL 304 DEGREASED & BAKED	4.0×10^{-12}	150	-	5	baked: 150^{o}C/24 hrs
	4.0×10^{-12}	300			300^{o}C/25 hrs
STAINLESS STEEL 304 VARIAN STD CLEANING	4.0×10^{-12}	150	VAR	5	150^{o}C/24 hrs
" "	1.5×10^{-10}	-	VAR	5	unbaked 10 hrs
" "	4.0×10^{-11}				unbaked 40 hrs
STAINLESS STEEL U15C LOW C 300 SERIES	1.0×10^{-12}	300	-	6	baked 300^{o}C/24 hrs
STAINLESS STEEL 321	1.4×10^{-9}	-	-	7	
STAINLESS STEEL 304 (Degreased)	8×10^{-11}	-	-	5	unbaked 40 hrs-vac
STAINLESS STEEL 304 (Varian Std. Clean)	4×10^{-12}	-	-	4	baked 150^{o}C24hrs-vac
STEEL - 4750 MACHINED & GROUND	4.5×10^{-10}	25	ALC	3	
STEEL - 4750 AS ROLLED	5.7×10^{-9}	25	ALC	3	
TEFLON (PTFE)	1.5×10^{-7}	-	-	9	4 hrs
" "	7.5×10^{-6}	-	-	10	4 hrs
TEFLON PTFE (wire sleeving)	2.5×10^{-8}	-	DUP	7	
TITANIUM 6AL 4V	1.8×10^{-9}	-	-	7	
TORR-SEAL	1×10^{-5}	25	VAR	VMC	1 hr
" "	7×10^{-7}	25	VAR	"	4 hrs
" "	8×10^{-6}	135	VAR	"	
VAC-SEAL	2×10^{-8}	-	PEC	"	
VITON - A	2.3×10^{-7}	-	-	9	4 hrs & 24hrs @200^{o}C

*(Torr-liter-sec^{-1}cm^{-2})

MATERIALS	OUTGASSING RATE *	TEMP (^{o}C)	MFGR.	REF	NOTES
VITON - A	5×10^{-11}	25	DUP	1	after bake 12hrs/200^{o}C
"	2×10^{-9}	100	DUP	1	" "
"	1×10^{-7}	200	DUP	1	" "
VITON - A	$\sim 10^{-7}$	-	DUP	7	
VITON - E60C	6×10^{-10}	95	DUP	2	
" "	2×10^{-9}	144	DUP	2	
" "	1×10^{-8}	170	DUP	2	
" "	1×10^{-7}	225	DUP	2	

*(Torr-liter-sec^{-1}cm^{-2})

Manufacturer Code"

SEL	Space Environmental Laboratories
VAR	Varian
DUP	E. I. du Pont de Nemours & Company
ABR	Amphenol Corporation
BOC	Bray Oil Company
CIB	CIBA
ALC	Allegheny - Ludlum Company
PEC	Perkin-Elmer Corporation

References:

1. Hait, Paul W., The Applications of Polyimide to Ultra-High Vacuum Seals. VACUUM, vol.17 No. 10, 1967.
2. de Chernatony, L. Recent Advances in Elastomer Technology for UHV Applications. VACUUM vol. 27, no.10/11, 1977.
3. Yamamoto, R.M. & Harvey, J. Outgassing Measurements and Results Used in Designing the Doublet III Neutral Beam Injector System, 8th Symposium on Engineering Problems of Fusion Research, 1979.
4. Hill, K. W., Vacuum-Pumping Calculations for Day-1 TFTR Pulse Height Analyzer and Phase - 2 X-Ray Imaging System, Private Communication, September 1981, PPPL.
5. Strausser, Yale, Review of Outgassing Results, Varian Associates, Palo CA, date unknown (post 1967)
6. Calder, R. & Lewin, G., Reduction of Stainless Steel in Ultra High Vacuum, Brit. J. Appl. Phy. vol. 15, 1967.
7. Patrick, T. J., Space Environment & Vacuum Properties of Spacecraft Materials, Vacuum, vol 31, no 8/9, 1981.
8. Yoshikawa, et al, Outgassing Rates Before, During and After Bake-out for various vacuum and first wall candidate materials of a Large Tokamak Device, ULVAC Corp., Japan.
9. Patrick, T. J., Outgassing and the Choice of Materials for Space Instrumentation, VACUUM, vol. 23, no 11, 1973.
10. Santeler, D. J. et al, Outgassing of Materials, Vacuum Technology and Space Simulation, 1966, NTIS no N66-36129, pp 197-222.
11. Moore, R. UHV Compatibility of K-ramic, PPPL - TM - 302, May 1977.
12. Halama, H. J. & Herrera, J. C., Thermal Desorption of Gases from Aluminum Alloy AL6061, Their Rates and Activation Energies, J. Vac. Sci. Technol. vol 13, no 1, Jan-Feb 1976.
13. Peacock, R. N., Practical Selection of Elastomer Materials for Vacuum Seals, HPS Corp. Pub.
14. H. Kiyama, S. Kiyama, K. Hakoda et al, Ceramic Toroidal Vacuum Chamber and Wall Conditioning for the ETL-TPE-2 Experiment, Proceeding of the 9th Symposium Engineering Problems of Fusion Energy Research, 1981. IEEE Pub No. 81CH1715-2 NPS, Vol. II.
15. Roth, A., Vacuum Sealing Techniques, Pergamon Press, Ltd., 1966, pp756-757.
16. Lewin, Gerhard, Fundamentals of Vac. Sci. & Tech. McGraw-Hill, 1965 pp 71-72.