

TOYO TANSO CARBON PRODUCTS

PERMA-FOIL[®]

Compound Material Products



TOYO TANSO

Inspiration for Innovation



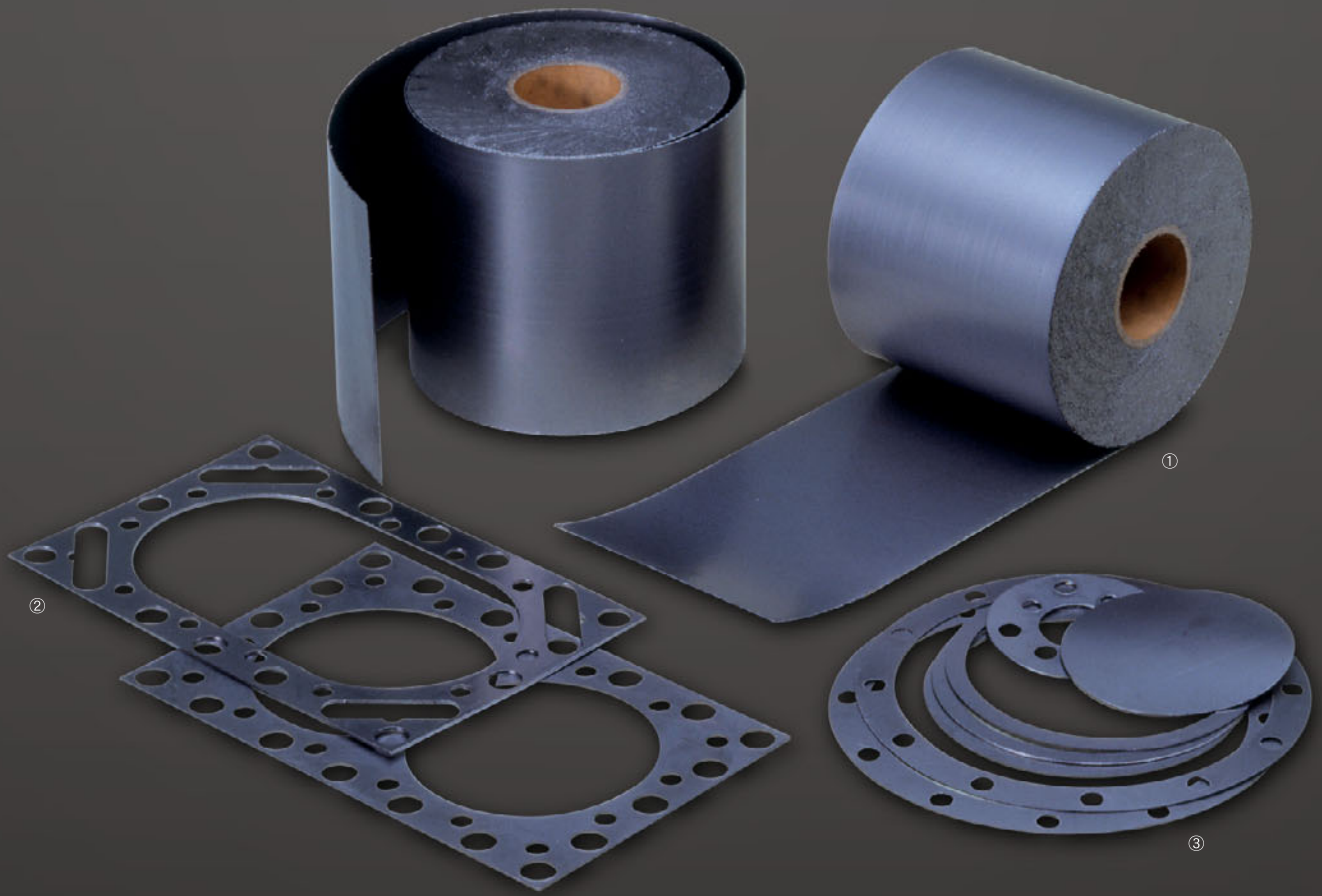
People and carbon An everlasting relationship.

Carbon has been a part of our life since ancient times. The benefits of carbon have never been far away from humans, making our lives more plentiful and comfortable. In 1974, we were the first company in Japan to successfully develop isotropic graphite, and thereafter rapidly expanding its possibilities. Isotropic graphite became a crucial material of state-of-the-art technologies in industries such as semi-conductors and aerospace. Currently, this material is being used in a wide range of applications over an ever-increasing number of fields. Toyo Tanso is dedicated to unlocking the unlimited potential of carbon and aims to ensure that the beneficial relationship between people and carbon is one that lasts forever.

PERMA-FOIL[®]

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Features of PERMA-FOIL®

PERMA-FOIL® is a generic term for the flexible graphite sheet that Toyo Tanso developed through our original manufacturing technology. It is a sheet graphite product that is formed using select acid treated natural graphite, which is compressed after undergoing high temperature expansion. Only natural graphite is used as a raw material, which yields highly flexible carbon with excellent heat resistance and chemical resistance. Other features include a high rate, excellent airtightness, and a high thermal conductivity

■ Excellent Self-Lubrication

PERMA-FOIL® has self-lubricating properties due to its layered crystal structure, making it appropriate for use in high-temperature atmospheres and in fields where fluids and lubricants are avoided. In particular, its coefficient of friction in an unlubricated condition is low compared with other materials, making adhesion difficult to occur.

■ Stable in the wide range of temperature

Since PERMA FOIL® is produced only from natural graphite without using a binder, it is stable in the wide range of temperature (-200°C~3200°C inert atmosphere) enabling it to be used.

■ Flexibility, Compressibility/Recovery

This graphite sheet has flexibility, previously unobtainable with existing graphite products, high recovery from compressive stress, good matching with counter materials, which make it ideal for use as a sealing material.

■ Excellent Chemical Resistance

PERMA-FOIL® has excellent chemical resistance (acid, base) and is chemically stable.

■ Excellent Thermal and Electrical Conductivity

Thermal and electrical conductivity are excellent parallel to surface, and PERMA-FOIL® is optimum as a heat release material and as a heat transfer material.

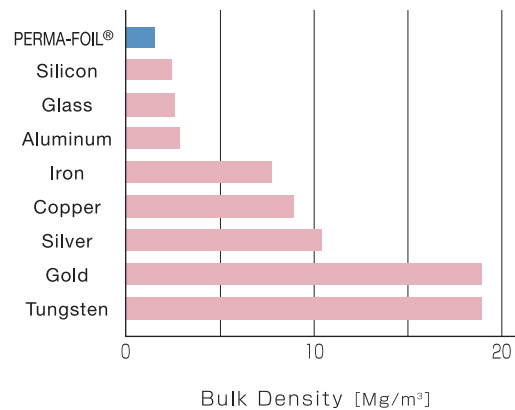
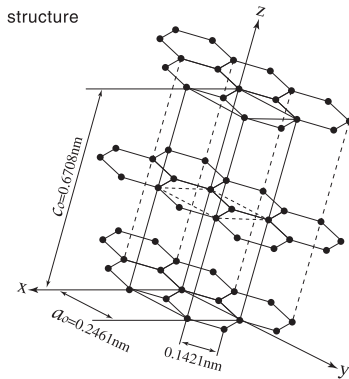
* Patent Number 3691836

■ Excellent Purity

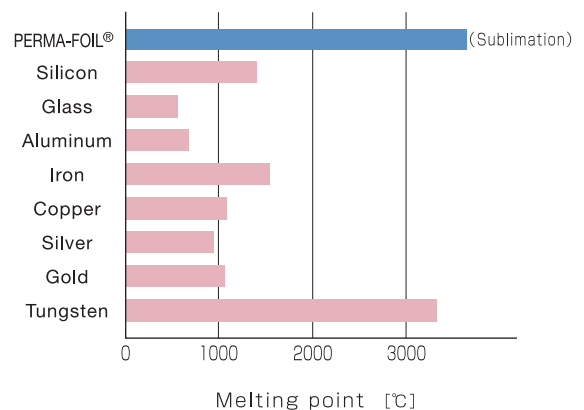
High purified products that have undergone high temperature treatment with halogen gas have a very high purity. Since it has extremely high purity, it is optimum for components in semiconductor, IT, or nuclear energy industry application.

* Patent Number 2620606

Graphite crystal structure



It is extremely light when compared with other metals.

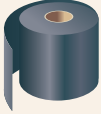
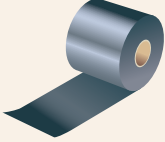




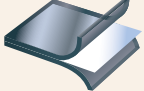
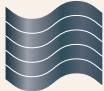


It has excellent heat resistance.

- ① PERMA-FOIL® Roll Products
- ② PERMA-FOIL® Punching Processed Product Samples
- ③ PERMA-FOIL® Punching Processed Product Samples

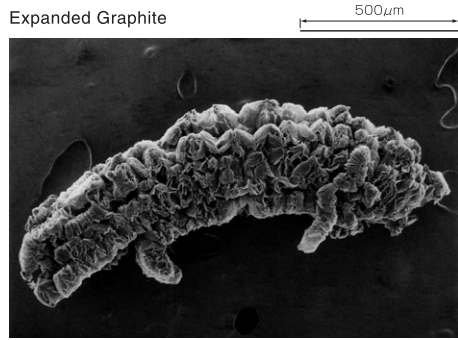
Grade and Application

PERMA-FOIL® has excellent sealing properties, durability, and machinability. High purity treated products are optimum as components in the nuclear energy industry, as spacers and packing used in the semiconductor industry, as radiator plates used in the electronics industry, and as other such components. Grades are arranged for all kinds of applications including: automotive gaskets, general industrial packing, parts for semiconductor equipment, corrosion resistant seals, IT industry applications, and a wide range of other applications. There is a wide assortment of forms of supplies, including roll products, cut products, and specialty products.

Grade	Characteristics	Application	Forms of Supplies
PF	PERMA-FOIL® Standard products	Automotive gaskets General industrial packing	  
PF-R2	Heat resistance improved version of standard products		
PF-HP	Low ash content products		
PF-G3	Corrosion resistance and Heat resistance improved version of R2 Products	Heat resistant gasket Packing	
PF-UHP, UHPU	High purified products	Parts for high purity furnace for semiconductor and nuclear applications. Heart release material Heat spreader.	
PF-A	Bonded products (Thickness ≥ 1.5mm)	Heat insulation material General industrial packing	
PF-SUS, AL	SUS, AL Foil Laminated products	Automotive gaskets General industrial packing	
Gather Sheet S	Gather sheets with adhesive tape	Flange gasket	
PF Powder 4, 8F	Pulverized expanded graphite products	General industrial packing Battery parts	Powder

※For available dimensions, please contact our sales department.

Manufacturing Process

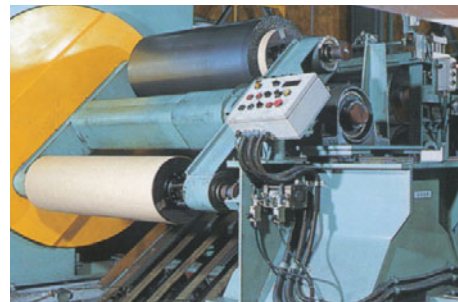
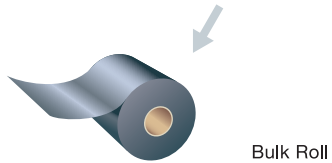
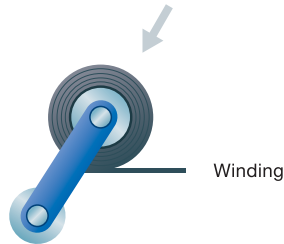
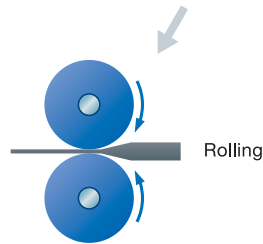
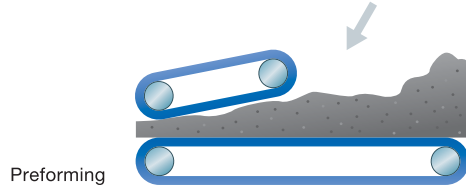
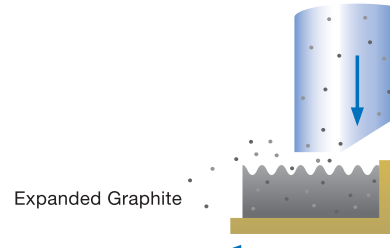


Through heat treatment, acid treated graphite becomes expanded graphite.

Acid Treated Graphite
(Acid treated graphite is natural graphite that has undergone acid treatment)



Expansion Treatment



Property Data

Typical properties

Item	Unit	Grade					
		PF	PF-R2	PF-HP	PF-G3	PF-UHPL	PF-UHP, UHPU
Operation Temperature	℃	-200~3200					
Thickness	mm	0.2~1.0	0.2~1.5	0.1~1.0	0.2~1.0	0.38	0.1~1.5
Bulk Density	Mg/m ³	0.5~1.1	0.5~1.1	0.5~1.1	0.5~1.1	1.0	1.0, 0.9
Oxidation Loss	mass %	40	25	40	3	5	5
Initial Oxidation Temperature	℃	440	730	630	850	820	820
Tensile Strength	MPa	4.9	5.2	4.9	5.1	6.3	6.3
Sulfur Content	mass ppm	900	900	900	900	<1	<1
Chlorine Content	mass ppm	<10	<10	<10	<10	<3	<3
Compression Rate	%	47					
Recovery Rate	%	15					
Stress Release Rate	%	1.0					
Ash Content	mass %	0.5	0.5	0.1	0.5	<20 mass ppm	<10 mass ppm
pH	—	5.1	5.1	5.1	5.1	7.0	7.0
Gas Permeability (Nitrogen, 0.1MPa Differential Pressure)	m ² /s	1.3 × 10 ⁻¹⁰					
Coefficient of Thermal Expansion	Parallel to surface	5 × 10 ⁻⁶					
	Perpendicular to surface	2 × 10 ⁻⁴					
Thermal Conductivity (25℃)	Parallel to surface	200					
	Perpendicular to surface	5					
Electrical Resistivity (25℃)	Parallel to surface	7					
	Perpendicular to surface	1,000					
Flamability	—	Equivalent to UL-94VO					

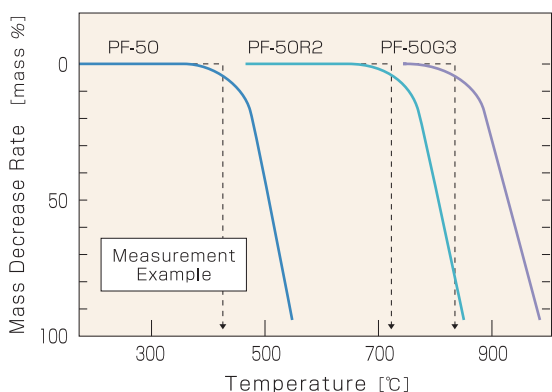
※The figures above are typical values, and are not guaranteed.

※Property data with the density of 1.0Mg/m³.

※Oxidation loss is the result of the measurement for 1hour at 670℃.

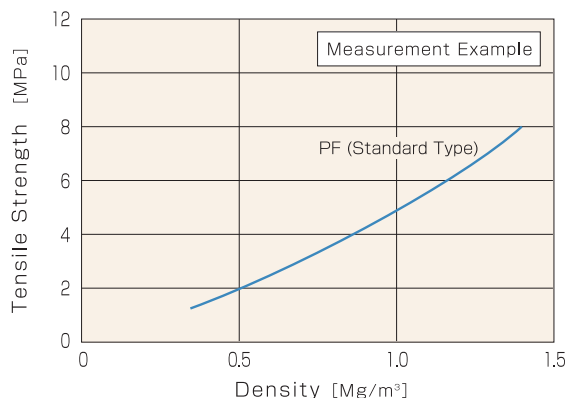
※Initial oxidation temperature represents the kick-off temperature of mass decrease by the result of the measurement using a thermobalance in the air atmosphere.

Initial Oxidation Temperature



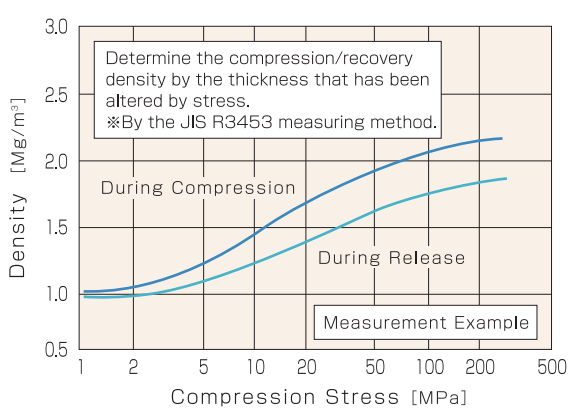
We have several grades that may suit customers' heat resistance requirements.

Relationship Between Density and Tensile Strength



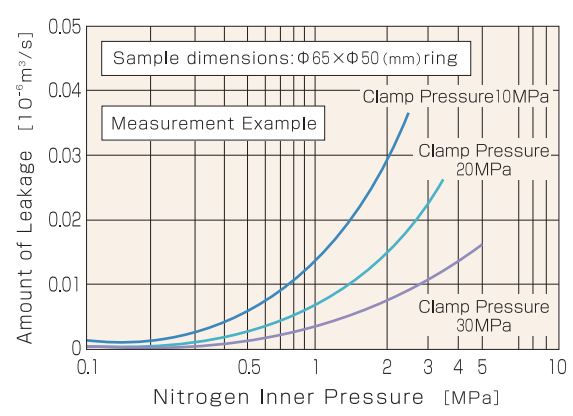
High density products have high strength.

■ The Relationship Between Density and Compression stress during Compression and Release (PF-50)



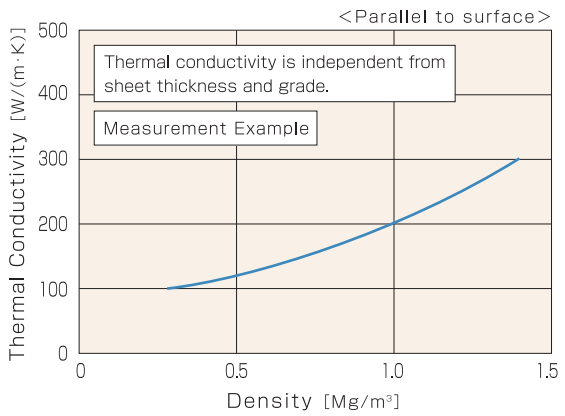
Excellent compressibility/recovery

■ The Relationship Between Clamp Pressure and Amount of Leakage (PF-50)



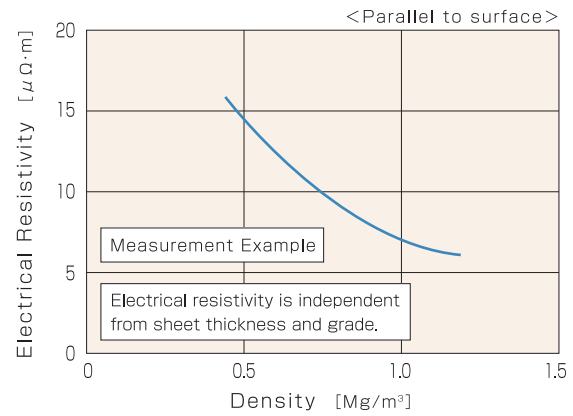
High sealing properties

■ The Relationship Between Density and Thermal Conductivity (25°C)

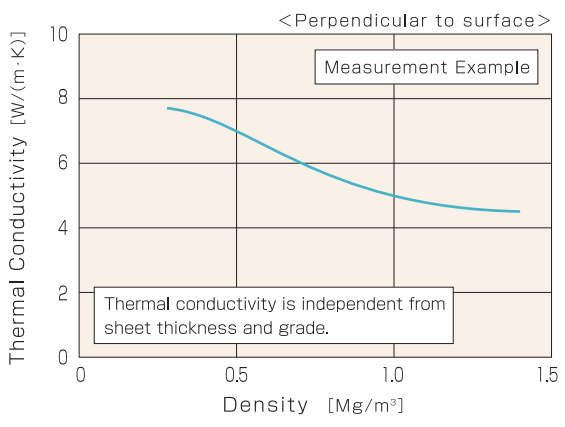


The thermal conductivity parallel to surface is excellent.

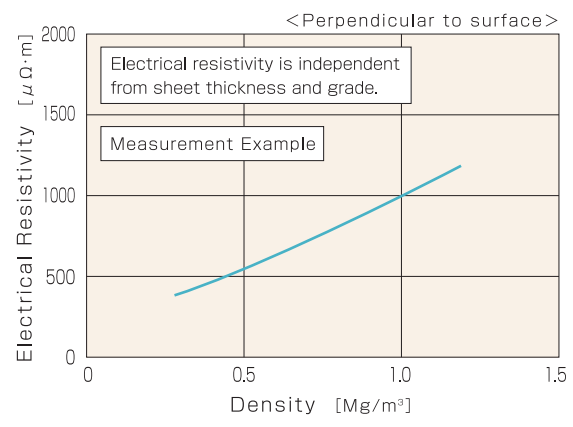
■ The Relationship Between Density and Electrical Resistivity (25°C)



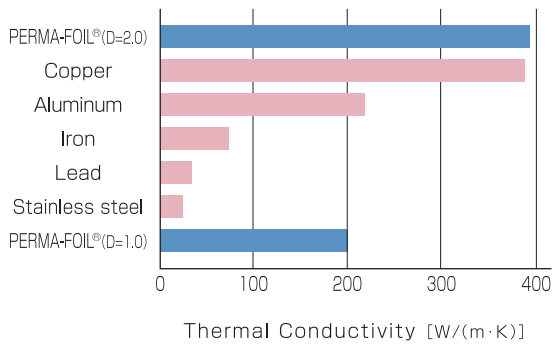
The electrical resistivity parallel to surface is low.



The insulating properties perpendicular to surface is excellent.

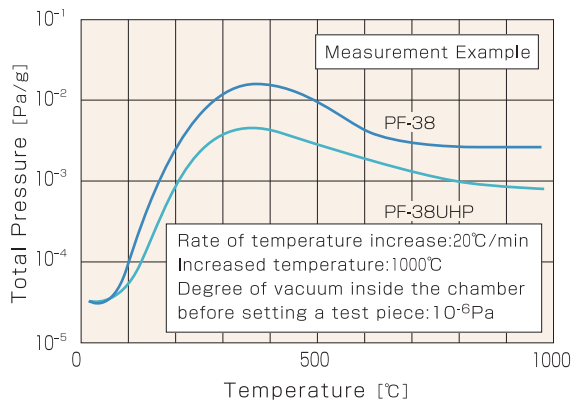


The electrical resistivity perpendicular to surface is high.



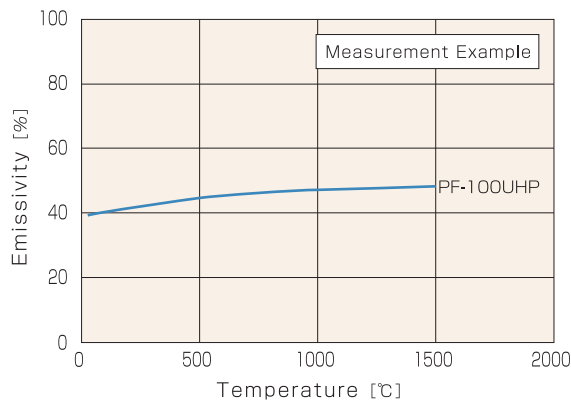
High density products have an extremely high thermal conductivity.

■ Thermal Desorption Spectrum (TDS)



Have an extremely low emitted gas amount.

■ Emissivity



■ Chemical Resistance

Chemical Substance	Concentration (mass%)	room temperature (30 Day Immersion)			50°C (30 Day Immersion)			85°C (6 Hour Immersion)		
		Thickness Increase	Weight Increase	Appearance	Thickness Increase	Weight Increase	Appearance	Thickness Increase	Weight Increase	Appearance
Sulfuric Acid	90				△	×	○	△	×	○
	95	△	×	△	△	×	×			
Nitric Acid	10	○	○	○	○	○	○			
	20	○	○	○	○	○	○			
Sulfuric Acid + Nitric Acid = 9:1		×	×	×						
Hydrochloric Acid	36				○	○	○	○	○	○
Phosphoric Acid	85				○	△	○	○	△	○
Hydrofluoric Acid	46	○	○	○						
Ammonia Water	28	○	○	○						
Sodium Hydroxide	25	○	○	○	○	○	○	○	○	○
Methanol	100	○	○	○						
Acetone	100	○	○	○						
Gasoline	100	○	○	○						

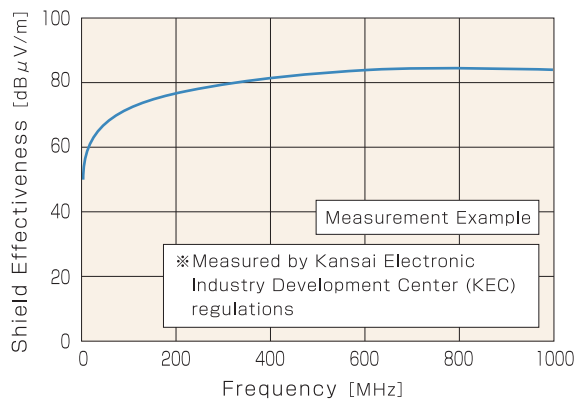
※○...No Change △...Slight Change ×...Significant Change
 ※Chemical resistance is independent from sheet thickness and grade.

■ Initial Reaction Temperatures With Various Substances

※Extracted from other publications

Reactant	Initial Reaction Temperature	Compounds of Reaction
Silicon Dioxide	1250°C	CO, Si, SiC
Copper	No Reaction	—
Magnesium	No Reaction	—
Iron	600~800°C	Fe ₃ C
Cobalt	218°C	CoC, Co ₃ C
Lead	No Reaction	—
Aluminum Oxide	1280°C	CO, Al, Al ₄ C ₃
Magnesium Oxide	1350°C	CO, Mg
Zirconium Oxide	1300°C	CO, Zr, ZrC

■ Electromagnetic Shield Characteristics (PF-50)



High electromagnetic shield characteristics.

■ Impurity Analysis Example

Units: mass ppm

Element	Element	
	Regular Products	High Purified Products
Li	<0.01	<0.01
Na	46	<0.05
K	1.9	<0.1
Cu	1.0	<0.08
Be	<0.02	<0.02
Mg	0.7	<0.02
Ca	40	<0.04
Zn	<0.1	<0.1
Al	90	<0.08
V	0.7	<0.07
S	900	<1.0
Fe	160	<0.04
Ni	<0.1	<0.1

Before actually using one of our products, please be sure to contact our sales department to consult on selecting the most appropriate grade.

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1. Catalog Contents Disclaimer

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Toyo Tanso Co., Ltd.

<http://www.toyotanso.co.jp>

■ Head Office
Umeda Daibiru, 10th Fl. 3-3-10 Umeda, Kita-Ku, Osaka 530-0001, Japan
Tel: 81-6-6451-2114 Fax: 81-6-6451-2186