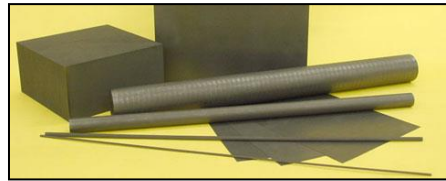


Graphite – Semiconductor & Ion Implant Grades

Graphite grades are categorized by the market they serve and then classified by grain size. Graphite materials are sold in bulk and as finished machined parts made to customer furnished specifications.

We offer several Semiconductor Grades and Ion Implant Grades including:

DFP, DFP-1C, DFP 3-2, PyroGraph. SFG, HPD, TRA, CZR, SCF, SCF-2, PLS & ZEE



Grade Chart

Typical Properties of POCO Grades							
Grade	SFG	DFP	HPD	TRA	CZR	SCF	PLS
Particle Size							
microns	1	4	5	5	6	6	10
μinches	40	160	200	200	240	240	400
Coefficient of Thermal Expansion							
microns/m °C	8.1	8.1	8.1	7.9	7.8	7.6	8.3
μin/in °F	4.5	4.5	4.5	4.4	4.3	4.2	4.6
Compressive Strength							
N/mm ²	170	140	150	125	105	170	110
psi	25,000	20,000	22,000	18,000	15,000	25,000	15,500
Flexural Strength							
N/mm ²	110	85	90	70	55	95	60
psi	16,000	12,000	13,000	10,000	8,000	13,500	8,500
Tensile Strength (1)							
N/mm ²	75	60	60	50	38	65	40
psi	11,000	8,500	9,000	7,000	5,500	9,500	6,000
Hardness							
SSH	85	74	80	72	68	91	65
Electrical Resistivity							
μohm·cm	1,950	1,500	2,000	1,650	1,900	2,800	1,220
μohm·in	770	600	790	650	750	960	480
Apparent Density							
g/cc	1.80	1.77	1.77	1.73	1.65	1.77	1.82
lb/in ³	0.065	0.064	0.064	0.063	0.06	0.064	0.066
Thermal Conductivity							
watts/m K	72	95	85	85	76	60	105
BTU·ft/hr·ft ² ·° F	42	55	50	50	44	35	60
Oxidation Threshold (2)							
°C	450	440	450	430	420	480	460
°F	840	820	840	810	790	900	860

(1) Estimated at 70% of flexural strength.

(2) Temperature that results in 1% weight loss in 24 hours. Oxidation threshold increases by approximately 100° C if graphite is purified. Excludes copper impregnated material.

DFP

Particle Size		Hardness	
microns	4	SSH	74
μ inches	160		
Coefficient of Thermal Expansion		Electrical Resistivity	
microns/m °C	8.1	μ ohm·cm	1,500
μ in/in °F	4.5	μ ohm·in	600
Compressive Strength		Apparent Density	
N/mm ²	140	g/cc	1.77
psi	20,000	lb/in ³	0.0640
Flexural Strength		Thermal Conductivity	
N/mm ²	85	watts/m K	95
psi	12,000	BTU·ft/hr·ft ² ·°F	55
Tensile Strength (1)		Oxidation Threshold (2)	
N/mm ²	60	°C	440
psi	8,500	°F	820

(1) Estimated at 70% of flexural strength.

(2) Temperature that results in 1% weight loss in 24 hours. Oxidation threshold increases by approximately 100°C if graphite is purified.

DFP-1C

Particle Size		Hardness	
microns	5	SSH	65
μ inches	200		
Coefficient of Thermal Expansion		Electrical Resistivity	
microns/m °C	8.5	μ ohm·cm	270
μ in/in °F	4.7	μ ohm·in	120
Compressive Strength		Apparent Density	
N/mm ²	210	g/cc	3.12
psi	30,500	lb/in ³	0.1120
Flexural Strength		Thermal Conductivity	
N/mm ²	117	watts/m K	175
psi	17,000	BTU·ft/hr·ft ² ·°F	100
Tensile Strength (1)		Oxidation Threshold (2)	
N/mm ²	65	°C	500
psi	9,500	°F	930

(1) Estimated at 70% of flexural strength.

(2) Temperature that results in 1% weight loss in 24 hours. Oxidation threshold increases by approximately 100°C if graphite is purified.

DFP-3-2

This is a high strength graphite that has reduced porosity. DFP-3-2 has long been the standard for components that exhibit long life and reduced erosion rates.

Typical Purified Poco Graphite: GDMS Elemental Data Analysis

Element	Concentration (ppm wt)
Na	<0.005*
Mg	<0.005*
Al	0.09
K	<0.005*
Ca	<0.005*
Ti	0.02
V	0.002
Mn	<0.001*
Fe	0.03
Ni	0.01
Cu	<0.001*
Zn	<0.005*

*Denotes value below detection limits

POCO PyroGraph

Pyrograph is pyrolytically infiltrated graphite. POCO's proprietary process infiltrates the base material to a minimum depth of 0.1 inch throughout the entire surface of the component. This process seals the graphite surface and reduces particle generation in the chamber.

The manufacturing process begins with a specially formulated graphite. Once a part has been machined, it goes through a purification process that typically results in a purity level of < 2ppm. The final step is a pyrolytic vapor infiltration that produces a hard, uniform surface. Vapor phase processing allows deeper penetration of the pyrolytic carbon into the base material.

Typical Purified Poco Graphite: GDMS Elemental Data Analysis

Element	Concentration (ppm wt)
Na	<0.005*
Mg	<0.005*
Al	0.09
K	<0.005*
Ca	<0.005*
Ti	0.02
V	0.002
Mn	<0.001*
Fe	0.03
Ni	0.01
Cu	<0.001*
Zn	<0.005*

*Denotes value below detection limits

SCF-2

An economic alternative to DFP-3-2, this 5-micron material is harder than DFP-3-2 and has high strengths without reduced porosity.

Typical Purified Poco Graphite: GDMS Elemental Data Analysis

Element	Concentration (ppm wt)
Na	<0.005*
Mg	<0.005*
Al	0.09
K	<0.005*
Ca	<0.005*
Ti	0.02
V	0.002
Mn	<0.001*
Fe	0.03
Ni	0.01
Cu	<0.001*
Zn	<0.005*

*Denotes value below detection limits

Typical Material Properties

	ZEE	DFP-3-2	SCF-2	PYROGRAPH
Particle Size	1	4	6	5
Apparent Density (g/cc)	1.77	1.82	1.77	1.56
Flexural Strength (psi)	15,000	12,000	13,500	7,750
Compressive Strength (psi)	30,000	20,000	25,000	14,200
Electrical Resistivity (μ -ohm-in)	1,260	600	960	790
Shore Hardness	100	74	91	66
CTE(μ -in/in/C)	8.4	8.1	7.6	7.5
Purity	99.9995%	99.9995%	99.9995%	99.9995%
Pyrolytic Carbon				12% pick-up

SFG

Particle Size		Hardness	
microns	1	SSH	85
μ -inches	40		
Coefficient of Thermal Expansion		Electrical Resistivity	
microns/m °C	8.1	μ -ohm·cm	1,950
μ -in/in °F	4.5	μ -ohm·in	770
Compressive Strength		Apparent Density	
N/mm ²	170	g/cc	1.80
psi	25,000	lb/in ³	0.0650
Flexural Strength		Thermal Conductivity	
N/mm ²	110	watts/m K	72
psi	16,000	BTU·ft/hr·ft ² ·°F	42
Tensile Strength (1)		Oxidation Threshold (2)	
N/mm ²	75	°C	450
psi	11,000	°F	840

(1) Estimated at 70% of flexural strength.

(2) Temperature that results in 1% weight loss in 24 hours. Oxidation threshold increases by approximately 100°C if graphite is purified.

HPD

Particle Size		Hardness	
microns	5	SSH	80
μinches	200		
Coefficient of Thermal Expansion		Electrical Resistivity	
microns/m °C	8.1	μohm·cm	2,000
μin/in °F	4.5	μohm·in	790
Compressive Strength		Apparent Density	
N/mm ²	150	g/cc	1.77
psi	22,000	lb/in ³	0.0640
Flexural Strength		Thermal Conductivity	
N/mm ²	90	watts/m K	85
psi	13,000	BTU·ft/hr·ft ² ·°F	50
Tensile Strength (1)		Oxidation Threshold (2)	
N/mm ²	60	°C	450
psi	9,000	°F	840

(1) Estimated at 70% of flexural strength.

(2) Temperature that results in 1% weight loss in 24 hours. Oxidation threshold increases by approximately 100°C if graphite is purified.

TRA

Particle Size		Hardness	
microns	5	SSH	72
μinches	200		
Coefficient of Thermal Expansion		Electrical Resistivity	
microns/m °C	7.9	μohm·cm	1,560
μin/in °F	4.4	μohm·in	615
Compressive Strength		Apparent Density	
N/mm ²	118	g/cc	1.72
psi	17,100	lb/in ³	0.0621
Flexural Strength		Thermal Conductivity	
N/mm ²	75	watts/m K	85
psi	10,900	BTU·ft/hr·ft ² ·°F	50
Tensile Strength (1)		Oxidation Threshold (2)	
N/mm ²	53	°C	450
psi	7,500	°F	840

(1) Estimated at 70% of flexural strength.

(2) Temperature that results in 1% weight loss in 24 hours. Oxidation threshold increases by approximately 100°C if graphite is purified.

CZR

Particle Size		Hardness	
microns	6	SSH	68
μ inches	240		
Coefficient of Thermal Expansion		Electrical Resistivity	
microns/m °C	7.8	μ ohm·cm	1,900
μ in/in °F	4.3	μ ohm·in	750
Compressive Strength		Apparent Density	
N/mm ²	105	g/cc	1.65
psi	15,000	lb/in ³	0.0600
Flexural Strength		Thermal Conductivity	
N/mm ²	55	watts/m K	76
psi	8,000	BTU·ft/hr·ft ² ·°F	44
Tensile Strength (1)		Oxidation Threshold (2)	
N/mm ²	38	°C	420
psi	5,500	°F	790

(1) Estimated at 70% of flexural strength.

(2) Temperature that results in 1% weight loss in 24 hours. Oxidation threshold increases by approximately 100° C if graphite is purified.

SCF

Particle Size		Hardness	
microns	6	SSH	91
μ inches	240		
Coefficient of Thermal Expansion		Electrical Resistivity	
microns/m °C	7.6	μ ohm·cm	2,800
μ in/in °F	4.2	μ ohm·in	960
Compressive Strength		Apparent Density	
N/mm ²	170	g/cc	1.77
psi	25,000	lb/in ³	0.0640
Flexural Strength		Thermal Conductivity	
N/mm ²	95	watts/m K	60
psi	13,500	BTU·ft/hr·ft ² ·°F	35
Tensile Strength (1)		Oxidation Threshold (2)	
N/mm ²	65	°C	480
psi	9,500	°F	900

(1) Estimated at 70% of flexural strength.

(2) Temperature that results in 1% weight loss in 24 hours. Oxidation threshold increases by approximately 100° C if graphite is purified.

PLS

Particle Size		Hardness	
microns	10	SSH	65
μinches	400		
Coefficient of Thermal Expansion		Electrical Resistivity	
microns/m °C	8.3	μohm·cm	1,220
μin/in °F	4.6	μohm·in	480
Compressive Strength		Apparent Density	
N/mm ²	110	g/cc	1.82
psi	15,500	lb/in ³	0.0660
Flexural Strength		Thermal Conductivity	
N/mm ²	60	watts/m K	105
psi	8,500	BTU·ft/hr·ft ² ·°F	60
Tensile Strength (1)		Oxidation Threshold (2)	
N/mm ²	40	°C	460
psi	6,000	°F	860

(1) Estimated at 70% of flexural strength.

(2) Temperature that results in 1% weight loss in 24 hours. Oxidation threshold increases by approximately 100°C if graphite is purified.

ZEE-2

POCO has been working closely with OEMs and fab customers to develop materials to support the requirements of the source and beam line areas of the implant chamber. Based on this work, POCO has expanded the existing family of materials, POCO PyroGraph, DFP-3-2 and SCF, targeted at the implant area to include POCO ZEE. Regardless of the type of implant, whether it is buried layer, N or P-well, punch through stop, SD, or Vt adjust, POCO has the right material to support the technology.

POCO ZEE

ZEE is a hard, wear-resistant material. This next generation ion implant material offers improved performance through the entire range of low to high-energy implants. POCO ZEE is high-purity, isotropic graphite with a true 1-micron grain size. A unique manufacturing process yields a graphite with elevated hardness and strengths that exhibits reduced wear and particle generation even in the highest energy environments. For more information, view the ZEE performance White Paper.

Particle Size		Electrical Resistivity	
microns	1	μohm-in	1,260
Apparent Density		Hardness	
g/cc	1.77	SSH	100
Flexural Strength		Coefficient of Thermal Expansion	
psi	15,000	μin/in/C	8.4
Compressive Strength		Purity	
psi	30,000		99.9995%

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