ELECTRONICS

Purified Graphite
Silicon Carbide Graphite Enhancement

Innovative solutions for the Semiconductor Industry

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For your wafer quality get our Ultra High Purity

Mersen offers to OEM and electronic component makers an innovative and wide range of smart and cost effective high temperature graphite based solutions. Above all, Mersen provides the lowest level of **elemental contamination** with its 99.9995% purified grades and allows its customers to manufacture and to process defect free materials and components.

Purity Ash content (ppm)

	Al	B	Fe	CA	Cu	Mg	Ni	Ti	V	Si	Pb	Sn	Mo	W	Zn	Cr	Total
Unpurified	1	2	31	51	1	1	74	22	95	5	1	1	1	1	1	2	300
< 20 ppm	0,5	<2	<2	<2	0,5	<0,2	0,5	<0,2	0,5	<2	0,1	0,1	0,1	0,1	0,1	0,1	11
< 5 ppm	<0,2	<0,8	<0,5	<0,5	ND	ND	<0,1	ND	<0,1	<0,5	ND	ND	ND	ND	ND	ND	2,7

ND - Not detected The above values are typical and are subject to change Brand name : PT (Europe) or CX (USA) for <20ppm.
UHP5 for purity quality <5ppm.

Mersen's clean room packaging allows a direct use in customer's clean rooms.

High density graphite grades with small grain size ensure that no particle contamination occurs in ultra high vacuum.

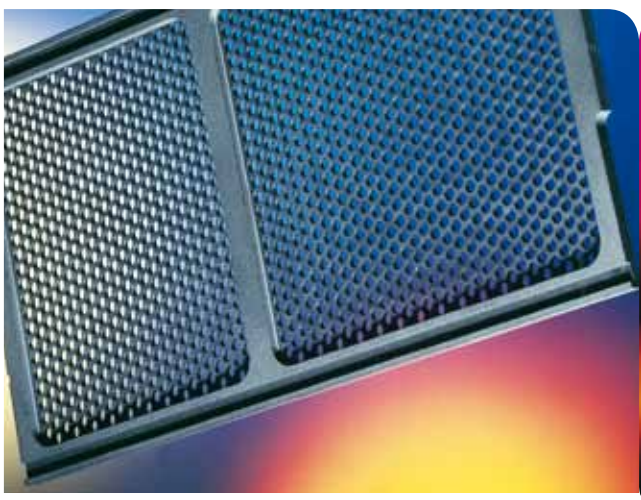
Mersen drastically reduces molecular contamination to a minimum with appropriate additional treatments, from outgasing, to closing graphite's natural porosity by impregnation.

Gas tight, to hermetic coatings, are renowned specialities of Mersen to prevent undesired wafer doping.

Mersen is qualified as a supplier for spare parts used in the electronic industry, from polysilicon production equipment to single crystal growing furnaces, silicon epitaxy, MOCVD reactors, dry etchers, ion implanters, glass to metal and metal to metal sealing furnaces, contaminants analysers…

From semiconductor material making

Application examples	Polysilicon reactors		Crystal growing furnace equipment			
Products	Polysilicon Heat exchanger	Polysilicon chucks	Crucible holder for Si SiGe AsGa InP Crystals, CaF^2 and others	Resistors & spill trays	Heatshields	Thermal insulation
Required functions	Get the widest range of proven solutions on the field Increase lifetime and resistance to corrosion	Prevent arcing in gaps Grow homogeneous layers of polysilicon Lower contact resistance Get the required resistivity of polycrystal	Contain hot melt and guarantee security of operations for 300 mm ingots Upgrade growers and increase pulled mass Lower heat up and cool down time Target below 1 ppm impurities content	Reduce number of mechanical parts Save space Radiate heat evenly Slow SiC conversion and increase lifetime Avoid hot spots Lessen electrical contact resistance and reduce malfunctions	Lower thermal inertia and have good supports to heavy loads Increase chemical inertia and lifetime	Substitute dusty felts, and graphite Shape in conic and cylindrical form Provide a good thermal radiation and thermal conduction barrier Adapt to inductive furnaces Stop dust
Solutions Best Choice Best Value	At low temperature impregnated grades are highly recommended At high temperature, impervious SiC coating up to 1,500°C increases lifetime	Soft material, very low CTE High Thermal conductivity along grain for cooling Large grains with lubricating properties Highly purified material 5 ppm Grade 2191	High FS and appropriate CTE to resist stress of SiC conversion, Light and strong material C/C materials Medium to high conductivity graphite C/C materials to reduce wall thickness Diminish reactive area, low pore size, Below 5 ppm for standard graphite grades, below 2 ppm for CC AEROLOR components Grades 2123, 2020, 2450 AEROLOR 2.5D C/C	Medium FS to allow for flexibility of assembly. 1 long resistor instead of too many small ones: C/C AEROLOR A252 Ultrasonic control to ensure homogeneity of material and hence thermal performance SiC coating reduces permeability of material Optimized by computer simulation Medium to high resistivity to lower thickness embodied current collector in C/C Below 20 ppm typical purity 2020 SiC coating 2 m high C/C cylinders	High FS: C/C AEROLOR A 252 Medium conductivity CVD inert pyrographite impregnation on A252 A252 composite material features below 2 ppm ash content A252 C/C material 2020, 2450 SiC coating	PAPYEX® WPTX is a rigid felt, being formed to size to make conic or cylindrical shapes PAPYEX® prevents heat radiation while RVG 4000 felt prevents heat conduction PAPYEX® external layering prevents dusting Purified under halogen gas flow at high temperature achieves lower than 5 ppm ash content Flexible Graphite PAPYEX® Rigid carbon thermal insulation CALCARB® and ISOLOR®



High Temperature mechanical interface Flexural Strength (FS), Tensile Strength (TS) density d, grain size (µm) cœfficient of thermal expansion (CTE)

Thermal transfer Thermal Conductivity λ

Chemical inertia Coating thickness, Pore diameter

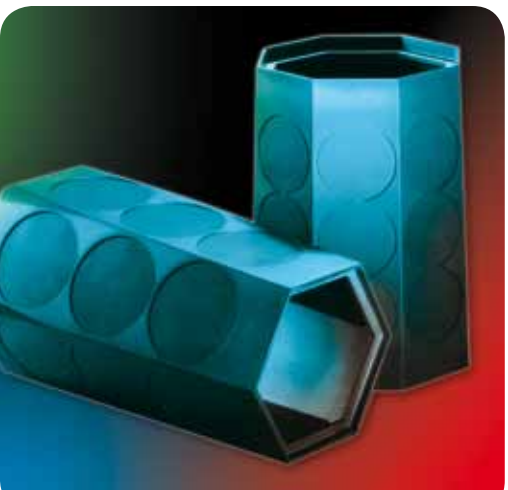
Electrical conductor Resistivity ρ or conductivity σ

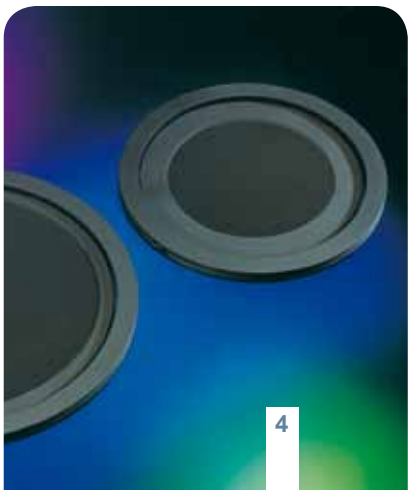
Contaminant free Ash content (ppm weight)

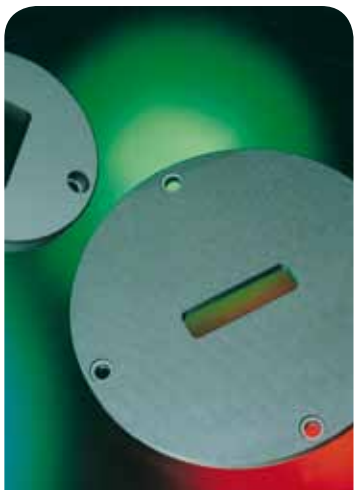
Best choice best value

... TO WAFER PROCESSING

Application examples	Wafer processing CVD & Epitaxy	Dry Etching	Ion Implanting	Packaging	Electronic Tubes	Contaminant analysis	
Products	Barrels and pancakes Single wafer susceptors MOCVD equipment Compound growth	Electrodes	Beam line components	Tools: jigs, brazing or sealing assemblies for semiconductors and connectors	Electrodes anode for Xray targets	Gas analyzing crucibles	Containers and lab accessories
Required functions	Avoid peeling off and ensure coating on all surface Achieve the best laminar gas flow pattern Guanrantee eveness of thermal profile Prevent any contamination or impurities diffusion Perform radiative or inductive process Lower contamination	Resist ablation Use under high voltage	Resist thermal shock Spread out energy of beam impact Ablation resistant Ground perfectly Faster pump down No particle release under beam impact	Adapt glass or other material thermal expansion Withstand wear Even thermal gradients Increase lifetime Provide a reliable thermal resistance Guarantee required electrical insulation	Withstand centrifugal force, Provide good match with tungsten layer Radiate stored heat in vacuum Be inert Under Vacuum To achieve and keep reliable high vacuum	Contain hot melts No wetting from metals Effective resistive heating Reliable measure	Alternative to platinum crucibles Resist most of etchants and acids No undesired reactions
Solutions Best Choice Best Value	CTE match between graphite and SIC graphite precision machining Coating emissivity and graphite homogeneity High thermal conductivity required Impervious SIC coating Tuned resistivity Coating and graphite grades meet 20 ppm criteria. Specific grid patterns engineered to avoid contamination SiC coating	High density grades, pyrocoat or bulk pyrographite Medium conductivity Fine grain and low porosity Low to medium resistivity Below 20 ppm 2120, 2123 pyrocoating bulk pyrographite Glassy carbon	Shock resistant grade i.e. low Young modulus, low CTE, high conductivity, high FS Very high conductivity Fine grain, high density grade. Very low resistivity Vitreous impregnation close porosity to trap dust 2120, 2340 Vitreous impregnation	Adapted CTE: high density grade High thermal conductivity Purification removes oxidation catalysts Medium resistivity for resistive heating: resistance tuned by fine hole drilling Reduce dust or electrically conductive traces on glass 2120, 2318,...	High FS High thermal conductivity Low resistivity Lower porosity Outgased grade as an option Below 20 ppm 2123, 2120, 2320	Large grains Medium to high resistivity Highest purity up to 2 ppm 2191	No open porosity Purification to eradicate oxidation catalysts Glassy carbon





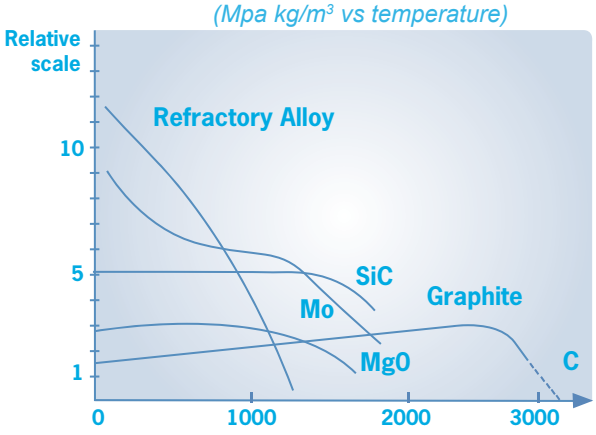


FUNDAMENTAL REASONS FOR YOU TO GET TH SOLUTION:

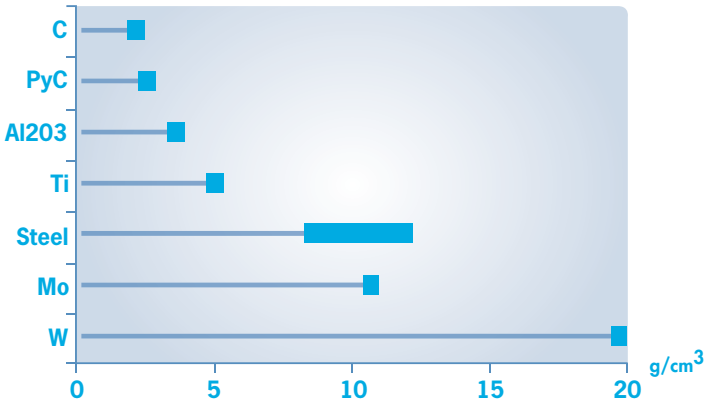
OEM and electronic component makers have **6** good **fundamental** reasons to order Mersen graphite based products for their High Temperature applications:

1 When most of refractory metals contaminate and collapse at high temperatures, Mersen's quality graphite, as the most refractory natural element, stands **mechanically** in high temperature processes.

Graphite a strong material
Specific flexural Strength
(Mpa kg/m³ vs temperature)

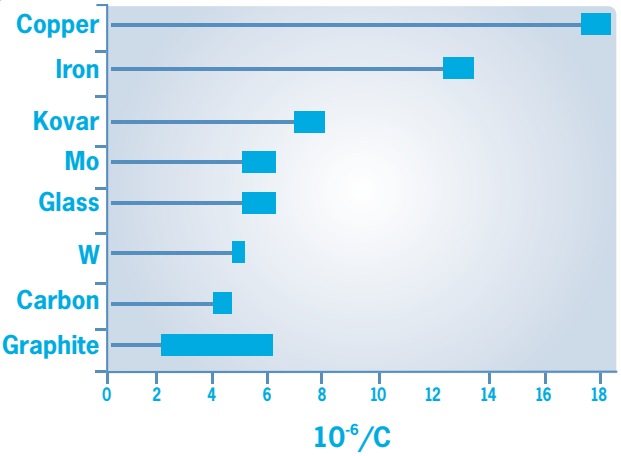


Graphite a light refractory material

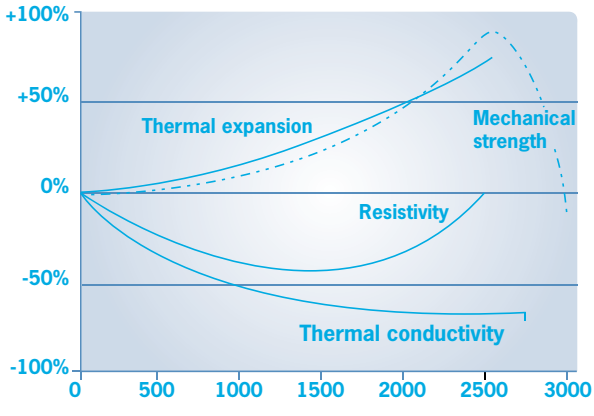


Mersen graphite compounds, with their steady and reliable behavior versus temperature, interface ideally to dimensional requirements.

Mersen wide range of thermal expansion coefficients meet most interface requirements



Graphite materials typical main characteristics variation versus temperature to room temperature properties



Mersen knows how to tune graphite performance to the heaviest thermal shocks, while choosing the adequate blend of powders, as well as the suitable process to create the most adequate microstructure.

To shorten customer's process time, Mersen features a range of special light and strong graphite and Carbon-Carbon (C/C) products, lowering mass to be heated and then cutting heat up and cool downtime.

HE BEST VALUE FROM THE BEST

2

Mersen puts **chemical** reactions with its graphite and C/C product range under control: for any given environment at high temperature, with the most aggressive etchants, Mersen offers the best grades and provides exceptional lifetime to its customers, at the lowest cost of ownership.

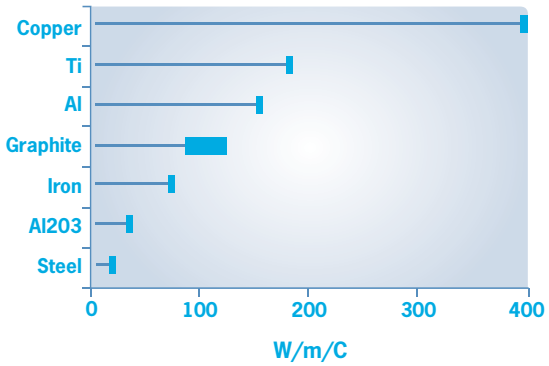
Resistance to oxidation can be drastically increased with optimal treatments and coatings, modifying permeability up to desired tightness.

	Graphite	Impregnated graphite	Vitreous impregnation	SiC coating	Glassy Carbon	Pyrocarbon coating	Solid Pyrocarbon
Permeability cm^2/s	10^{-1}	10^{-2}	10^{-3}	10^{-5}	10^{-11}	10^{-12}	10^{-12}

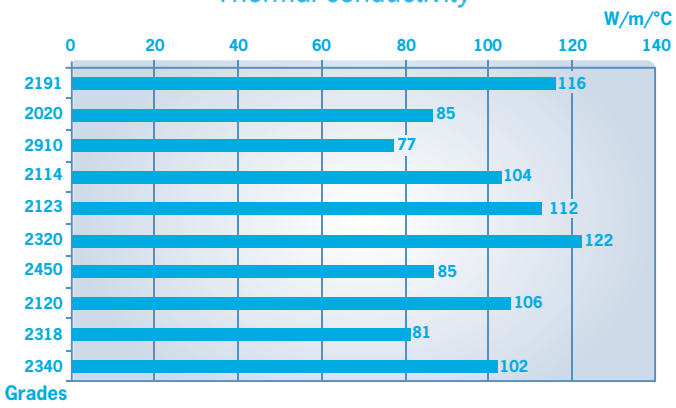
3

Mastering **thermal** transfer is key to high temperature processing: Mersen's high quality and homogeneous graphite based products ensure the most even thermal profile. From thermal transfer to thermal insulation, Mersen provides engineering resources to help customers simulate and design the best solution to perform the desired function.

Comparison of thermal conductivities



Thermal conductivity



4

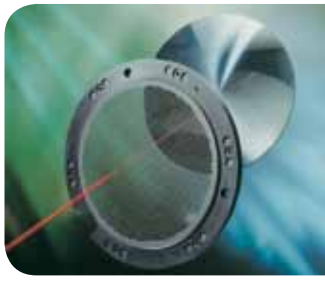
Mersen materials connect **electrically** in your systems to secure the most reliable grounding, to create the highest accelerating power or the most efficient resistive or inductive heating. Selection of purified iso-molded grades with the correct microstructure guarantees a safe electrical contact.

5

Most of the functions offered by Mersen graphite based products have a high service to value ratio. They are a **cost effective** solution compared to most refractory metals. Easier to machine, these graphite materials are produced by the worldwide leader Mersen, in large quantities, through a lean organization at the lowest cost, according to the highest quality standards.

6

Mersen is a worldwide group, and is a local partner to every customer. Its affiliates provide close service and quick delivery to every customer throughout the world.



A WIDE RANGE OF HIGH PURITY PRODUCTS

Purified graphite

Grade	Density	Grain size micron	Porosity %	FS (MPa)	CTE, $10^{-6}°C^{-1}$	Resistivity µ Ω cm	Thermal conductivity W/m°C	Standard Max. Size* mm
2191	1.75	15	12	44	4.2	1090	116	540x540x1830
2020	1.77	15	9	45	4.3	1550	85	530x635x1830 1030x1080x325 ø 610x1830 ø 915x760 ø 1500 on request
2910	1.74	30	17	30	4.1	1600	77	ø 640x1830
2114	1.81	13	10	52	5.3	1240	104	308x620x915
2123	1.84	13	8	58	5.5	1140	112	308x620x915
2320	1.82	13	10	50	5.0	1060	122	308x620x915
2450	1.86	15	8	45	4.3	1550	85	on request
2120	1.84	8	7	65	6.0	1220	106	308x620x915
2318	1.86	5	6	76	5.7	1600	81	152x308x620
2340	1.88	4	13	90	7.2	1270	102	305x305x100

* ask for specific size

Specialties

Vitreous carbon impregnation

Reference	T max	Depth of impregnation
VCI	450 °C (under O-atmosphere) - 2800 °C (inert)	> 6 mm

Silicon Carbide coating

Reference	T max	Density	Open porosity	Rf (MPa)	CTE $10^{-6}°C^{-1}$	Coating thickness	Hardness	Young modulus GPa
CARBOSIL	1700 °C	3.2	impervious to most gases and liquids	350	4.8	50-250 µm	2280 2950 Knoop	63

Glassy carbon

Reference	Density	Open porosity	CTE	Size
V25	1.45	0	2810^{-6}	limited to 3 mm wall thickness

Pyrocoating and bulk pyrocarbon

Reference	Density	Open porosity	Thermal conductivity
CARBOGRAF® 400 PYC Coating	2.05	~ 0 %	XY direction 300 - 500
CARBOGRAF® 430 PYC Bulk			Z direction 7

Carbon / Carbon AEROLOR®

Reference	Density	FS (MPa)	Flexural modulus (GPa)	Maximum Size
A252	1.70	100	10	Tube length 3000 mm Ring ø 2200 mm

Rigid carbon insulation CALCARB®

Reference	Density	Thermal conductivity at 400°C (W/m°C)	Thermal conductivity at 2,000°C (W/m°C)	Max. size
CBCF 18-2000	0.18	0.25 (Vacuum)	1.00 (Vacuum)	1,500 x 1,500 x 160 mm

Flexible graphite

Reference	Thickness mm	Width	Density	Emissivity Coefficient
PAPYEX®	0.5 to 1.5	1000 mm	1.0	0.74

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