Engineering
Materials

SPECIALTY CARBONS FOR CARBON BRUSHES

TIMREX®
TIMCAL Graphite

TIMREX®
TIMCAL Coke

TIMREX® C-THERM™
TIMCAL Graphite

imerys-graphite-and-carbon.com

IMERYS
Graphite & Carbon

Imerys Graphite & Carbon

WHO ARE WE?

Imerys Graphite & Carbon has a strong tradition and history in carbon manufacturing. Its first manufacturing operation was founded in 1908.
Today, Imerys Graphite & Carbon facilities produce and market a large variety of synthetic and natural graphite powders, conductive carbon blacks and water-based dispersions of consistent high quality.
Adhering to a philosophy of Total Quality Management and continuous process improvement, all Imerys Graphite & Carbon manufacturing plants comply with ISO 9001:2008.
Imerys Graphite & Carbon is committed to produce highly specialized graphite and carbon materials for today's and tomorrow's customers needs.
Imerys Graphite & Carbon belongs to Imerys, the world leader in mineral-based specialties for industry.

WHERE ARE WE LOCATED?

With headquarters located in Switzerland, Imerys Graphite & Carbon has an international presence with production facilities and commercial offices located in key markets around the globe. The Group's industrial and commercial activities are managed by an experienced multinational team of more than 430 employees from many countries on three continents.

For the updated list of commercial offices and distributors please visit www.imerys-graphite-and-carbon.com

Lac-des-Îles, Canada
Mining, purification and sieving of natural graphite flakes

HQ Bodio, Switzerland
Graphitization and processing of synthetic graphite, manufacturing of water-based dispersions, processing of natural graphite and coke, and manufacturing and processing of silicon carbide

Changzhou, China
Manufacturing of descaling agents and processing of natural graphite

Terrebonne, Canada
Exfoliation of natural graphite, processing of natural and synthetic graphite

Willebroek, Belgium
Manufacturing and processing of conductive carbon black

Fuji, Japan
Manufacturing of water-based dispersions

WHAT IS OUR MISSION?

To promote our economic, social and cultural advancement with enthusiasm, efficiency and dynamism by offering value, reliability and quality to ensure the lasting success of our customers.

WHAT IS OUR VISION?

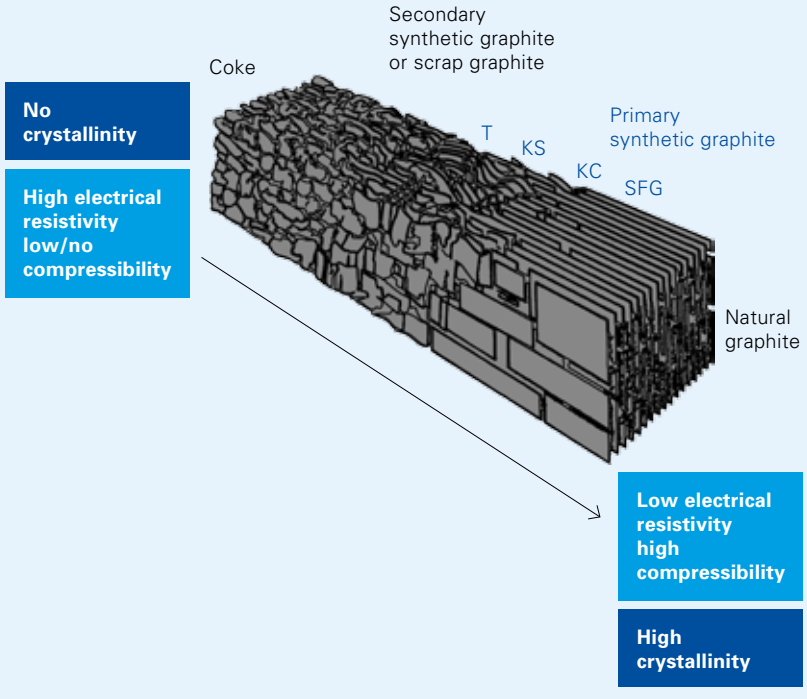
To be the worldwide leader and to be recognized as the reference for innovative capability in the field of carbon powder-based solutions.

Our value proposition

We at Imerys Graphite & Carbon deliver tailor made solutions for Carbon brushes market with superior consistency of key products' parameters: purity, crystallinity, particles size distribution, oversize control.

We at Imerys Graphite & Carbon address with our portfolio and with our R&D efforts the key requirements of Carbon brushes industry:

APPLICATION REQUIREMENTS	RELATED ISSUE	CARBON ADDITIVES TECHNICAL REQUIREMENTS INVOLVED	BENEFITS FROM IMERYS GRAPHITE PORTFOLIO
Electrical resistivity	Different resistivity depending on application	Various crystallinity levels and Particles Size Distribution (PSD).	Large variety of solutions, in terms of crystallinity and PSD.
Long life of electric motor	Wear resistance (electrical and mechanical)	High Purity, specific crystallinity and PSD for a tailored resistivity and friction coefficient (μ).	Consistent, high purity. Large variety of solutions, in terms of crystallinity and PSD. Thermal conductivity additive C-THERM™.
		Commutation film formation.	Special additive for transfer film's thickness control.
		Good adhesion between resin and graphite.	Engineered particles' surface, optimized PSD.
Low carbon brush cost	Low resin consumption	Optimized PSD.	Large variety of solutions, in terms of PSD.
Good commutation, low noise, low sparking	Transfer film behavior, Vibration damping	Various crystallinity levels and PSD (depending on application).	Large variety of solutions, in terms of crystallinity and PSD.



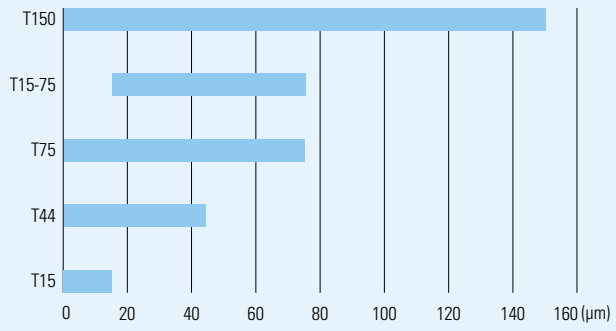
Inspired by F.P. Bowden, D. Tabor (1964), "The friction and lubrication of solids", Oxford University Press, UK.

Overview of Imerys Graphite & Carbon solutions

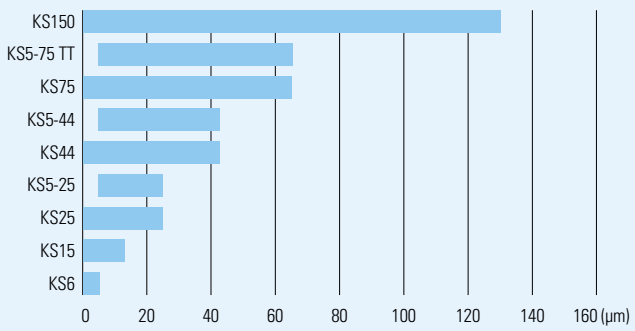
			CARBON BRUSHES TYPE		PROPERTIES	
Graphite powders		%C min.	Resin bonded	Copper sintered	Electrical resistivity	Compressibility
Primary synthetic graphite	T	99.9%	○		High	Low
	KS	99.9%	○	●	Medium high	Medium
	KC	99.9%	●	○	Medium low	Medium high
	SFG	99.9%	○	○	Low	High
Natural graphite flakes	BE	99.5%	○	○	Low	High
	Flakes	94.0-96.0%		○	Low	High
Special additives					Application benefits	
Petroleum coke		99.5-99.7%	○	○	Stabilization of friction coefficient	
C-THERM™		97.5-99.7%	○		High thermal conductivity for lower wear	
HRG High resistivity graphite		99.9%	○		Very high el. resistivity, low oil absorption	
ENSACO carbon black		99.9%	○		Reduction of el. resistivity, mechanical resistance	

○ Especially recommended ● Recommended

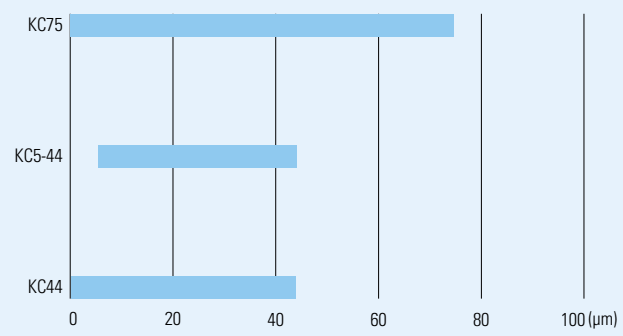
High resistivity primary synthetic graphite



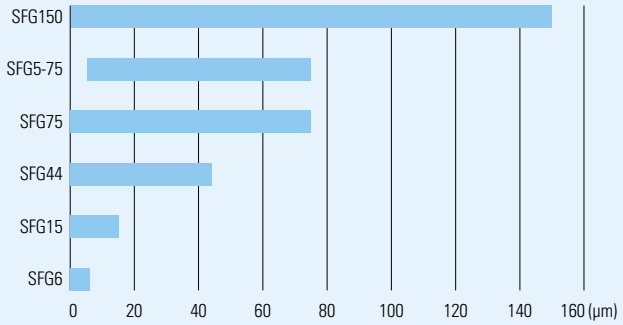
Medium-high resistivity primary synthetic graphite



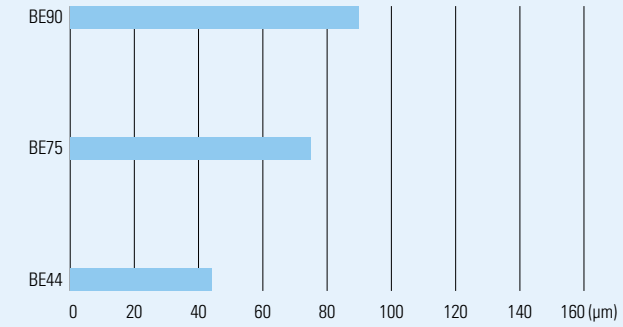
Medium-low resistivity primary synthetic graphite



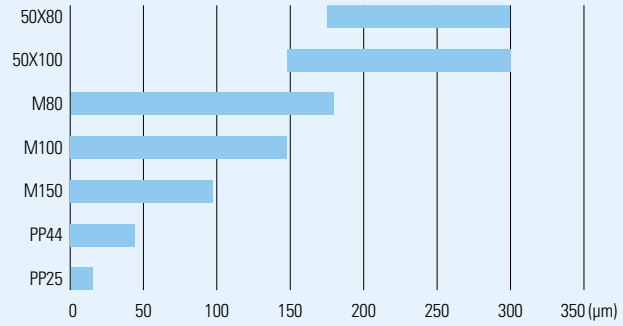
Low resistivity primary synthetic graphite



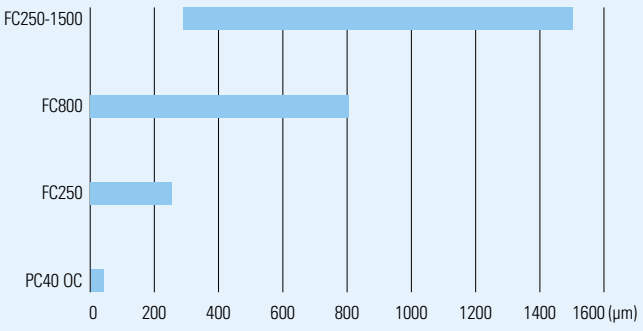
Natural flakes >99.5%C



Natural flakes 94 to 96%C



Calcinated petroleum coke



Tests methods

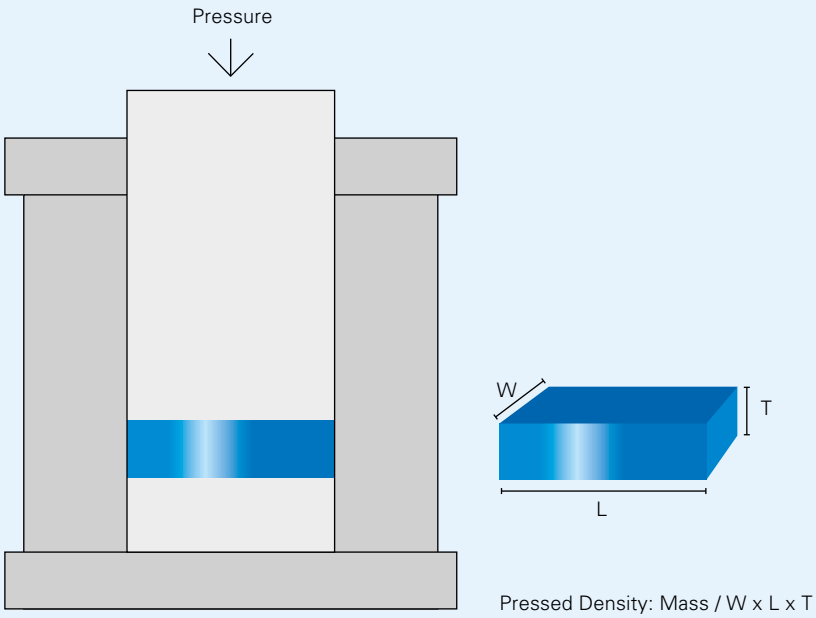
SAMPLES PREPARATION

Model Carbon brushes have been prepared in R&D lab following the standard procedure:

- Mixing: graphite powder is dry mixed with phenolic resin powder (typically 80% wt. graphite – 20% wt. resin or 70% wt. graphite – 30% wt. resin)
- Compaction: the mixed powders are pressed in a rectangular mould (either 20 x 30 mm^2, 50x12 mm^2 or 5x35 mm^2) at different pressures (from 1 t/cm^2 to 5 t/cm^2)
- Curing: the pressed samples are cured in an oven according to the following thermal treatment: 25 -> 80 °C (120 minutes), 80 -> 135 °C (660 minutes), 135 -> 180 °C (270 minutes), 120 minutes at 180 °C, cooling

PRESSED DENSITY

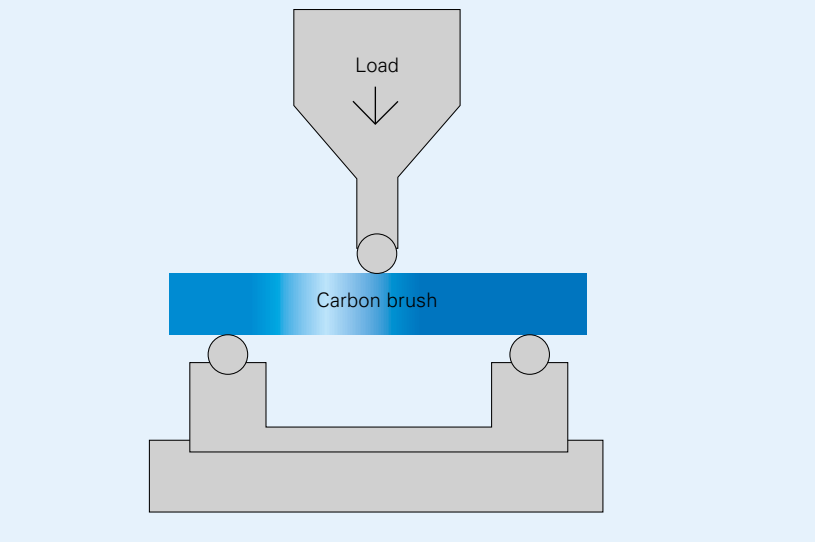
The dimensions of the model carbon brushes are measured after the thermal treatment with a micrometer, the weight is measured with a precision balance, and the density is calculated (mass/volume).



Pressed Density: Mass / W x L x T

BENDING STRENGTH

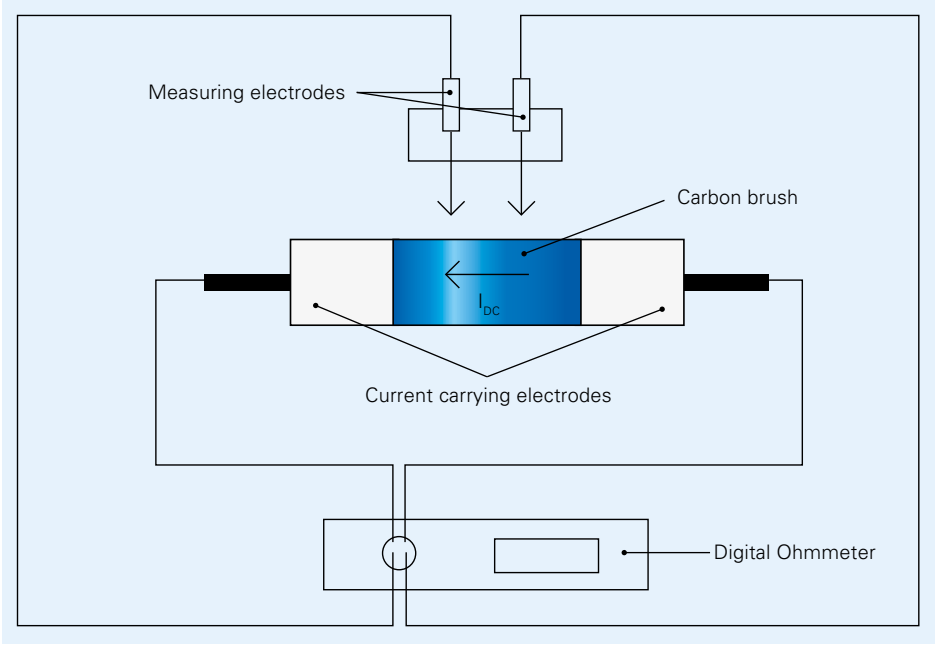
The transverse rupture strength is measured by three point method: the sample is placed on two supporting pins a set distance apart and a third loading pin is lowered from above at a constant rate until sample failure.



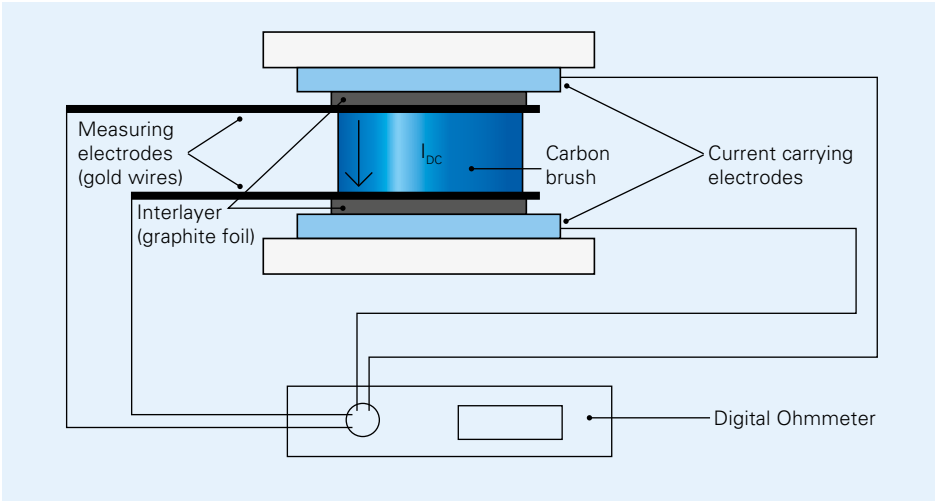
ELECTRICAL RESISTIVITY

The electrical resistivity is measured by the four-point method both in the in-plane (XY) and through-plane (Z) direction. The four-point method applied for these measurements greatly reduces the possibility of errors due to poor contacts.

XY (in-plane)

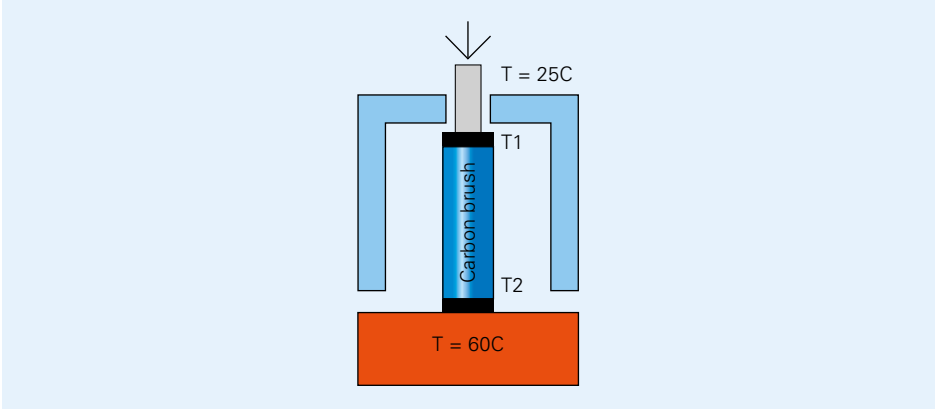


Z (through-plane)



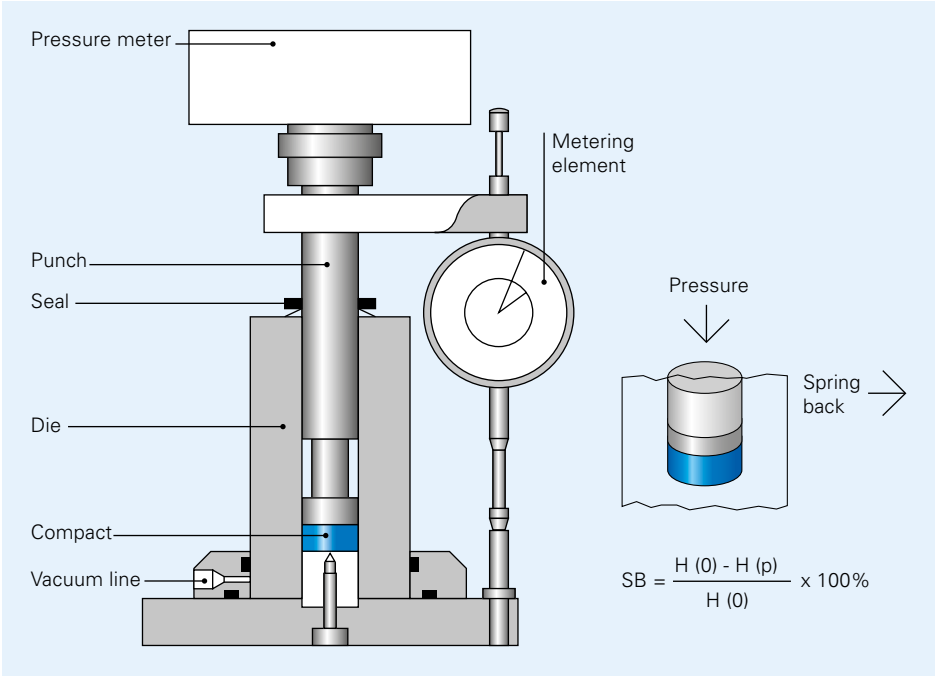
THERMAL CONDUCTIVITY

The thermal conductivity is measured with TCT416 instrument by Netzsch.



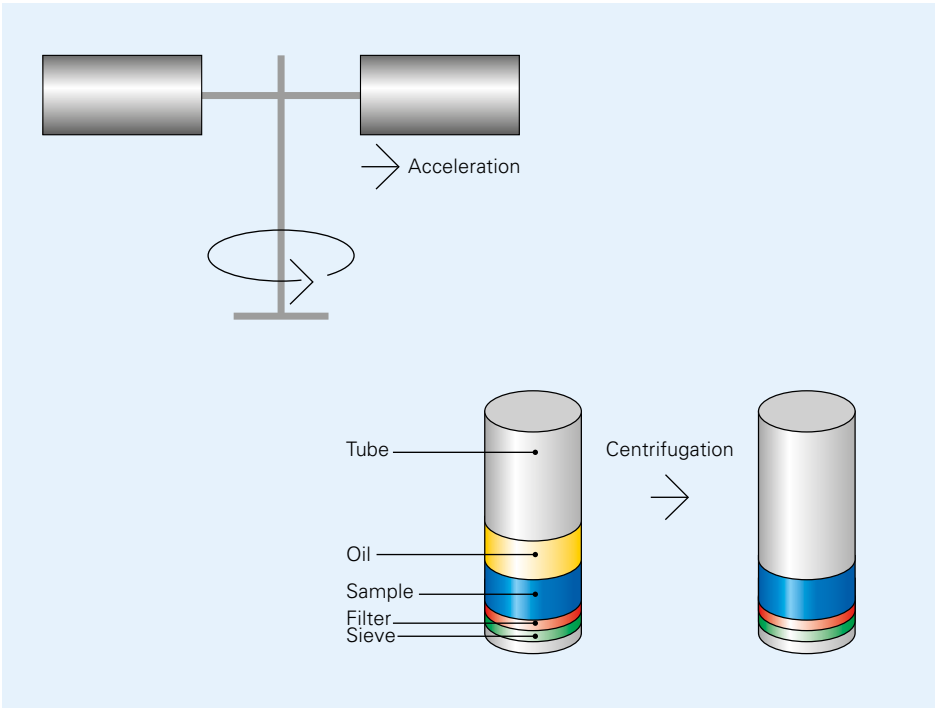
SPRING-BACK MEASURING METHOD

The measurement of elastic springback gives an indication of the the resilience of compacted graphite powder. A defined amount of dry powder is poured into a die. After inserting the punch and sealing the die, air is evacuated from the powder. Pressure is applied (p=0.477 t/cm^2) and the powder sample thickness is measured. Thickness is measured again after pressure has been released.



OIL ABSORPTION MEASURING METHOD

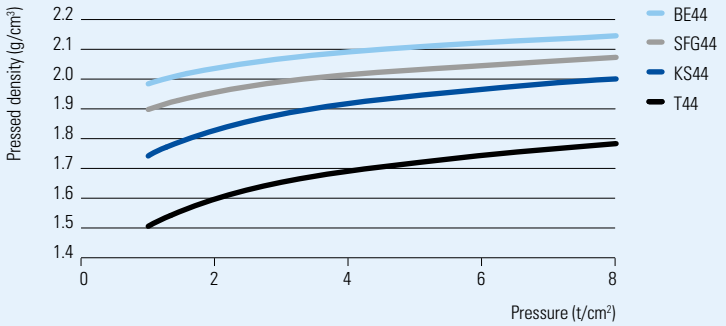
The oil absorption test is a special centrifugation method showing high reproducibility, developed by Imerys Graphite & Carbon. A special centrifuge tube is filled with 0.5 g of TIMREX® graphite powder and then covered with paraffin oil. After centrifuging, the tube is weighed and the oil absorption of 100 g of powder is calculated (based upon the weight increase of the 0.5 g sample).



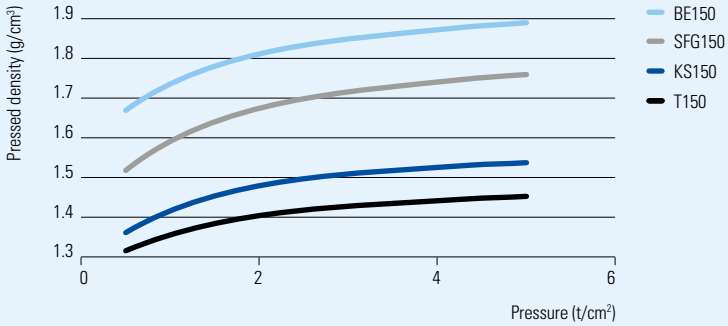
Data: pressed density

Pressed density vs. graphite type

Pure graphite

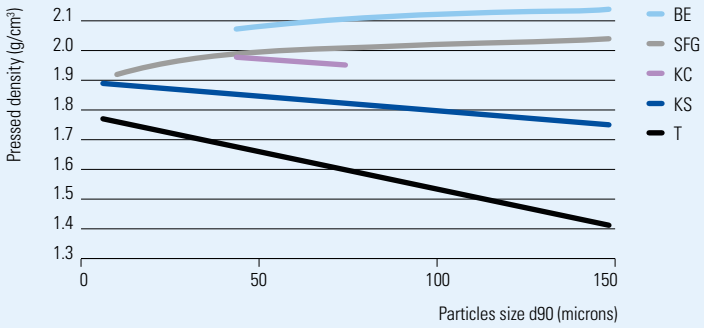


Carbon brush (20% wt. resin)

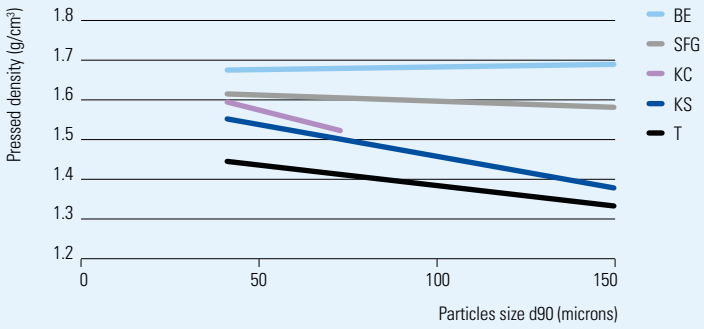


Pressed density vs. particles size distribution

Pure graphite (2.5 t/cm² compacting pressure)



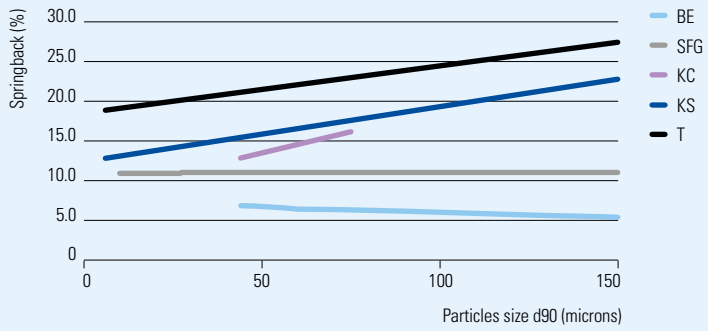
Carbon brush (30% wt. resin, 2 t/cm² compacting pressure)



Pressed density increases with increasing applied pressure. Natural graphite (BE) has higher pressed density compared to primary synthetic graphite. Pressed density of primary synthetic grades can be ranked according to crystallinity level (T<KS<KC<SFG). For synthetic graphite of type T and KS, the pressed density significantly decreases with increasing particle size.

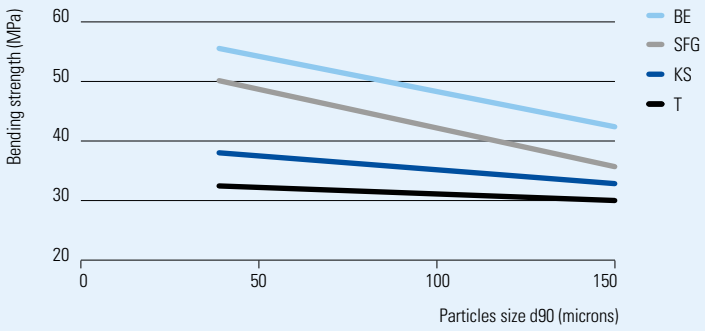
Data: springback and bending strength

Springback of pure graphite



Springback and compact density of graphite powders are physically connected parameters, which give information about the compressibility of powders and dimensional stability of compacts in any pressing direction. Springback is influenced mainly by compacting pressure, particle size distribution and crystalline structure of graphite. Typically, high crystalline structure results in low springback. Compacts produced from powders having a low springback can be easily formed and pressed with greater accuracy and density.

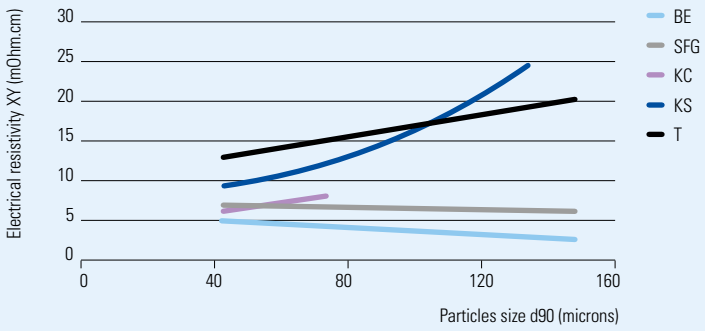
Carbon brush (30% wt. resin, 2 t/cm² compacting pressure)

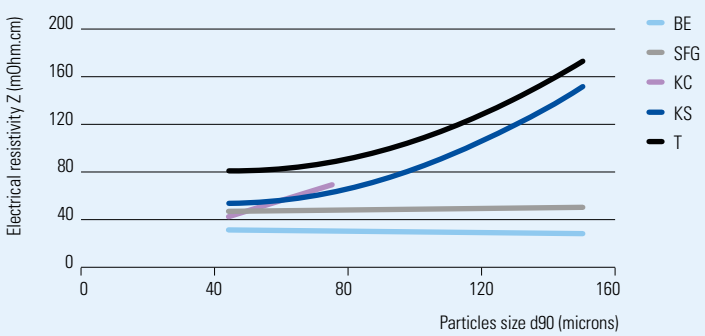


Bending strength of carbon brushes typically decreases with increasing particles size distribution (d90). This trend is more evident for high crystallinity grades (SFG, natural graphite).

Data: electrical resistivity

Carbon brush (30% wt. resin, 2 t/cm² compacting pressure)

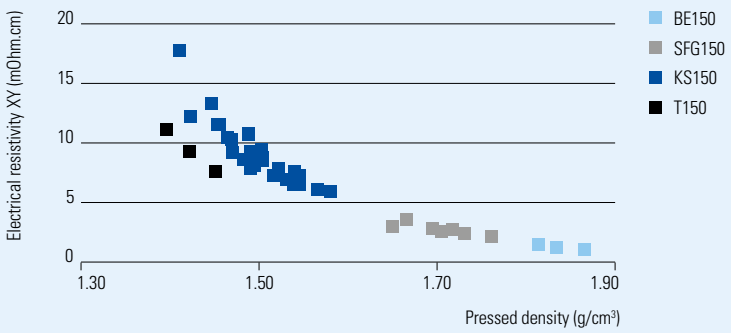


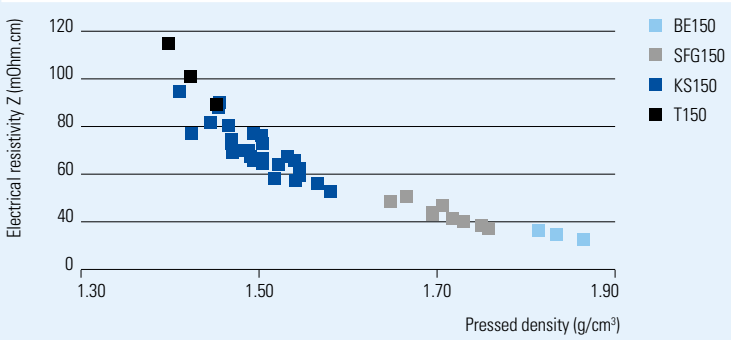


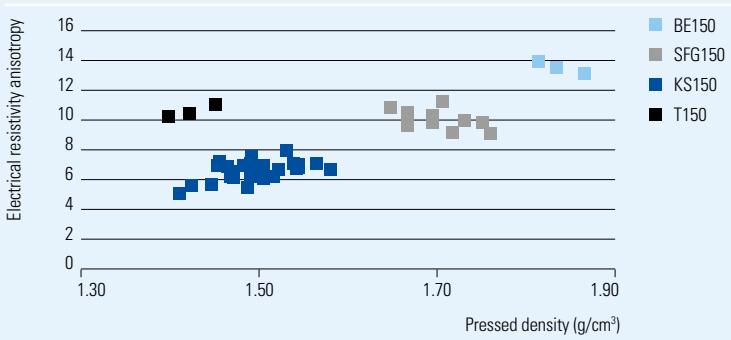
It has to be taken into consideration that the compressibility of each graphite grade affects the electrical resistivity because of micro-cracks and residual porosity of the carbon brush.

Data: electrical resistivity-anisotropy

Carbon brush (20% wt. resin, 2-5 t/cm² compacting pressure)







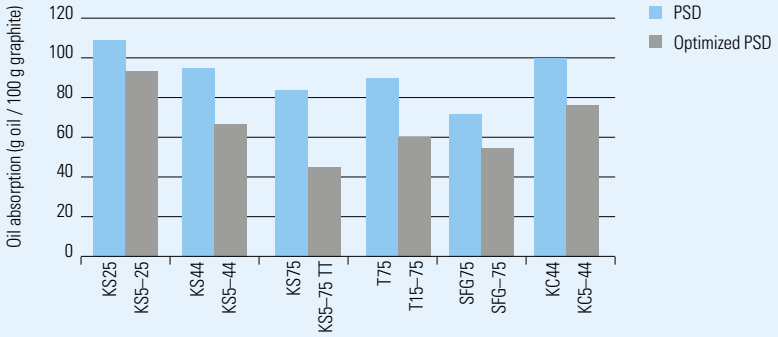
The electrical resistivity of carbon brushes is highly anisotropic, due to the orientation of the graphite particles during compression. Electrical resistivity anisotropy (through-plane / in-plane electrical resistivity) can range from a ratio of circa 6 for KS primary synthetic graphite up to circa 14 for natural graphite (BE).

Benefits from optimized particles size distribution

We at IMERYS Graphite & Carbon have developed a long time ago optimized particle size distributions to match a few key requirements of carbon brush producers:

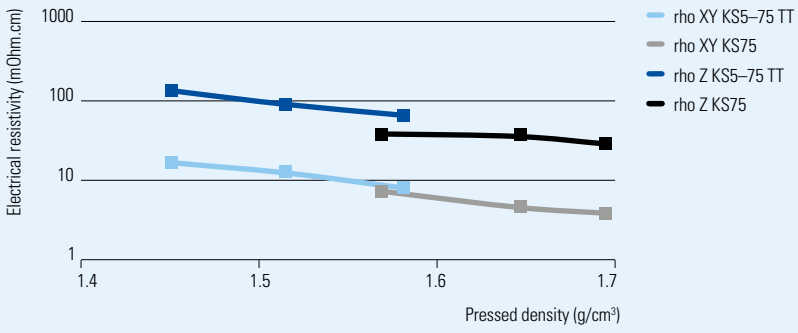
- Lower cost of carbon brushes can be obtained thanks to resin consumption reduced by 30 to 50%
- Higher wear resistance can be obtained thanks to reduced electrical wear (significantly less sparking) and mechanical wear
- Better commutation properties
- Lower brush density, with higher electrical resistivity and improved mechanical properties
- More elasticity for better noise-vibration performance

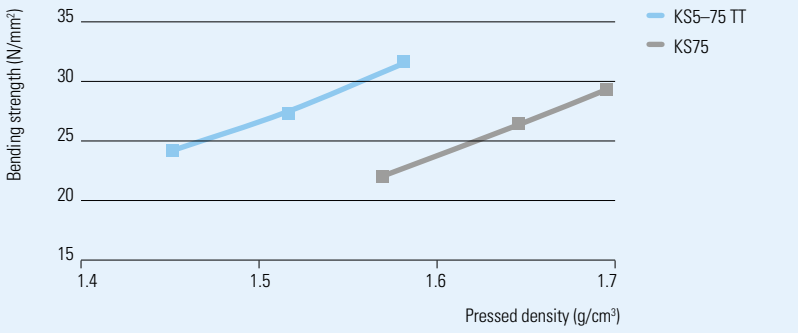
Oil absorption of pure graphite



The absorption behaviour is determined by particle size distribution, bulk density, crystalline structure, BET, surface porosity, particle shape and surface tension between graphite and binder.

Carbon brush (20% wt. resin, 2, 3, 5 t/cm² compacting pressure)



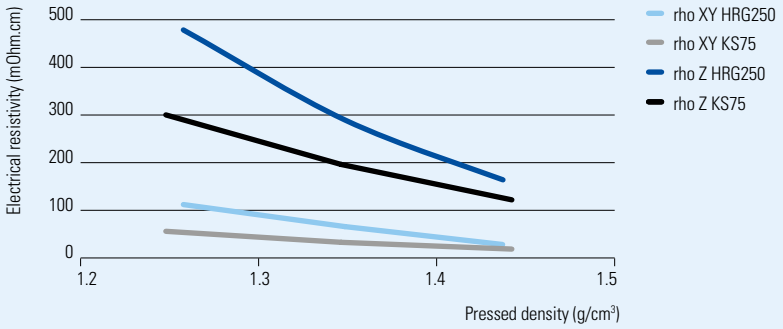


HRG GRAPHITE

High resistivity graphite (HRG) was developed to combine high resistivity (typical of secondary synthetic graphite, obtained by scrapping of electrodes) with the high mechanical performance given by primary synthetic graphite.

TYPICAL VALUES		KS44	KS75	HRG250
Malvern d10	[µm]	5	5	5
Malvern d50	[µm]	18	23	19
Malvern d90	[µm]	46	56	52
Oil Absorption	[%]	94	83	65
Scott density	[g/cm³]	0.19	0.24	0.31

Carbon brush (30% wt. resin 0.5–2 t/cm² compacting pressure)



HRG shows:

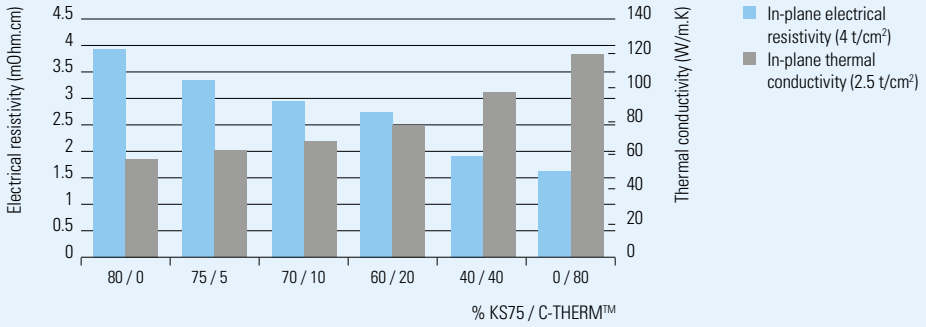
- Much higher resistivity with similar pressed density compared to T / KS
- Lower oil absorption by about 30% compared to KS
- Higher Scott density by about 40% compared to KS
- Mechanical properties similar or better than T / KS
- Improved wear properties thanks to optimized shape and surface structure of powder grains
- Improved commutation but lower efficiency (more power consumption $P=R*I^2$)

C-THERM™

C-THERM™ can be used as minor additive to improve the thermal conductivity (better heat dissipation, resulting in lower wear of the carbon brush). It can be also used to decrease the electrical resistivity of the carbon brush. It is available both as powder and soft granules with two different purity levels.

	POWDER	SOFT GRANULES
>99.7 %C	C-THERM™002	C-THERM™001
>97.5 %C	C-THERM™012	C-THERM™011

Carbon brush (20% wt. resin)



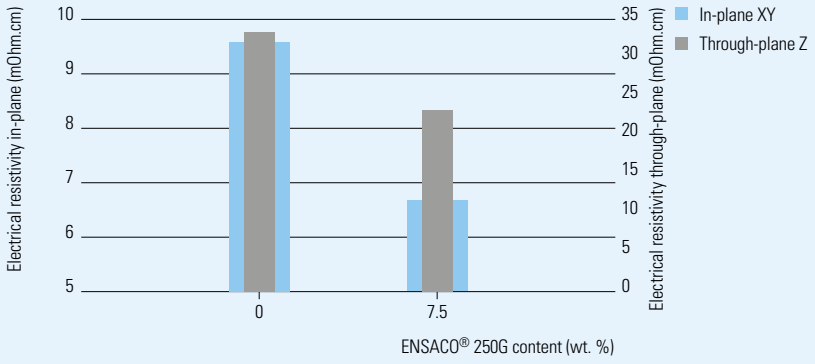
ENSACO CARBON BLACK / COKE

We at IMERYS Graphite & Carbon can provide special Carbon based additives for specific needs in carbon brushes formulation:

- stabilization of friction layer and friction coefficient (fine Coke powders, with oversize control)
- tailoring of electrical resistivity values (ENSACO® electrically conductive carbon black)

ENSACO® 250G is a conductive carbon black that can boost both in-plane and through-plane electrical conductivity of polymer-carbon composites.

Carbon brush (TIMREX® KS150 + ENSACO® 250G and 20% wt. resin; 2 t/cm² compacting pressure)



IMERYS
Graphite & Carbon

EUROPE

Imerys Graphite & Carbon Switzerland Ltd.
Group Head Office • Strada Industriale 12 • 6743 Bodio • Switzerland
Tel: +41 91 873 20 10 • Fax: +41 91 873 20 19 • graphiteandcarbon.ch@imerys.com

Imerys Graphite & Carbon Belgium SA
Brownfieldlaan 19 • 2830 Willebroek • Belgium
Tel: +32 3 886 71 81 • Fax: +32 3 886 47 73 • graphiteandcarbon.be@imerys.com

Imerys Graphite & Carbon Germany GmbH
Berliner Allee 47 • 40212 Düsseldorf • Germany
Tel: +49 211 130 66 70 • Fax: +49 211 130 667 13 • graphiteandcarbon.de@imerys.com

France Representative Office c/o Imerys
154-156 rue de l'Université • 75007 Paris • France
Tel: +33 1 495 565 90/91 • Fax: +33 1 495 565 95 • graphiteandcarbon.fr@imerys.com

UK Representative Office
Tel: +44 1 270 212 263 • Fax: +44 1 270 212 263 • graphiteandcarbon.uk@imerys.com

ASIA-PACIFIC

Imerys Graphite & Carbon Japan K.K.
Tokyo Club Building 13F • 3-2-6 Kasumigaseki • Chiyoda-ku • Tokyo 100-0013 • Japan
Tel: +81 3 551 032 50 • Fax: +81 3 551 032 51 • graphiteandcarbon.jp@imerys.com

Imerys Graphite & Carbon (Changzhou) Co. Ltd.
188# Taishan Road • Hi-Tech Zone • Changzhou 213022 • China
Tel: +86 519 851 008 01 • Fax: +86 519 851 013 22 • graphiteandcarbon.cn@imerys.com

Shanghai Branch Office c/o Imerys
1438 Hong Qiao Road • Chang Ning District 6F • Gubei International Fortune Centre II
Shanghai 201103 • China
Tel: + 86 21 2223 0136 • Fax: + 86 21 2223 0199 • graphiteandcarbon.cn@imerys.com

Singapore Representative Office c/o Imerys Asia Pacific
80 Robinson Road #19-02 • 068898 Singapore
Tel: +65 67 996 060 • Fax: +65 67 996 061 • graphiteandcarbon.sg@imerys.com

AMERICAS

Imerys Graphite & Carbon USA Inc.
29299 Clemens Road 1-L • Westlake (OH) 44145 • USA
Tel: +1 440 871 75 04 • Fax: +1 440 871 60 26 • graphiteandcarbon.us@imerys.com

Imerys Graphite & Carbon Canada Inc.
990 rue Fernand-Poitras • Terrebonne (QC) J6Y 1V1 • Canada
Tel: +1 450 622 91 91 • Fax: +1 450 622 86 92 • graphiteandcarbon.ca@imerys.com