# SPECIALTY CARBONS For **Carbon Brushes**

TIMREX®TIMREX®ENSACO®GraphiteC-THERM™Carbon BlackGraphiteGraphite









IMERYS CARBON SOLUTIONS – HIGH PERFORMANCE SOLUTIONS FOR CARBON BRUSHES



### **INNOVATIVE LEADERSHIP**

Innovative leadership and technical expertise make Imerys Graphite & Carbon the perfect partner for the development of solutions for the carbon brush industry.

Serving this market for decades, close collaboration with customers has led to the development of solutions suited to both resin-bonded and sintered-metallic carbon brushes. Our product offer includes high-purity primary synthetic graphites and high aspect ratio graphites with varying particle size distributions. In addition we offer specialty additives including conductive carbon blacks and petroleum cokes. This allows our customers to find the ideal solution depending on the level of electrical conductivity, wear resistance, and commutation required for their final application.







### IMERYS GRAPHITE & CARBON SOLUTIONS FOR CARBON BRUSHES

### **CUSTOMIZED SOLUTIONS**

Our sophisticated production processes allow us to deliver tailor-made solutions for the carbon brush market with superior consistency of key product parameters including: purity, crystallinity, particles size distribution (PSD), and oversize control.

Our dedicated team of R&D experts work closely with customers to understand the needs of their specific application and to identify the best solution.

PERFORMANCE REQUIREMENTS	GRAPHITE PROPERTIES IMPACTING PERFORMANCE	BENEFITS OF IMERYS PRODUCTS
Electrical resistivity (requirements are dependent on the specific end application)	<ul><li>✓ Crystallinity</li><li>✓ PSD</li></ul>	Wide portfolio of solutions in terms of crystallinity and particle size distribution
Durability of motor (both mechanical and electrical durability)	<ul> <li>Purity</li> <li>Product consistency (with respect to the crystallinity and PSD)</li> </ul>	<ul> <li>Exceptionally high purity</li> <li>Consistency</li> <li>Wide portfolio of solutions in terms of crystallinity and particle size distribution</li> <li>Thermal conductivity solutions</li> </ul>
		Special additives to control the thickness of the transfer film
	Good adhesion between resin and graphite	<ul> <li>Engineered particle surface</li> <li>Optimized PSD</li> </ul>
High performance to price/ratio (low resin consumption)	Optimized PSD for application	Wide portfolio of offer with respect to PSD
Good commutation, low noise, low sparking (transfer film behaviour and vibration reduction)	Optimized crystallinity and PSD for specific application	Wide portfolio of solutions in terms of crystallinity and particle size distribution

• 16



### **OUR PORTFOLIO**

## PRIMARY SYNTHETIC GRAPHITES

TIMREX® LINES	% CARBON MINIMUM	ELECTRICAL RESISTIVITY	COMPRESSIBILITY	CRYSTALLINITY
т	99.9%	High	Low	Medium
ĸs	99.9%	Medium high	Medium	Medium
кс	99.9%	Medium low	Medium high	Medium high
SFG	99.9%	Low	High	High

### **OTHER SPECIALTY CARBON ADDITIVES**

% CARBON MINIMUM	APPLICATION BENEFITS
99.5%	Stabilization of friction coefficient
97.5 - 99.7%	High thermal conductivity for lower wear
99.9%	Reduction of electrical resistivity, mechanical resistance
99.9%	Low oil absorption, high Scott density
	% CARBON         MINIMUM         99.5%         97.5 - 99.7%         99.9%         99.9%



### **OUR PORTFOLIO**





Calcinated petroleum coke







Medium-high resistivity primary synthetic graphite



Low resistivity primary synthetic graphite



### **BENEFITS**

### **OPTIMIZED PARTICLE SIZE DISTRIBUTION (PSD)**

Imerys Graphite & Carbon has many years of experience in developing product solutions with optimal PSD to meet the key requirements of carbon brush manufacturers:

- Reduction of resin consumption by 30 to 50%
   resulting in cost reduction
- Solution Enhanced durability due to reduced mechanical and electrical wear (less sparking)
- ⊘ Improved commutation properties
- Solution Lower brush density, with higher electrical resistivity and improved mechanical properties
- ℅ More elasticity for better noise-vibration performance



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



1.65

1.70

1.75

Electrical resistivity (m0hm.cm)

1.40

1.45

1.50

1.55

Pressed density (g/cm3)

1.60



### **TIMREX® SPL50**

**SPL50** has a similar PSD as other 44 micron graphite grades (with a slightly higher d10).

It has a high crystallinity – similar to that of SFG44 while having a much higher Scott density.

This allows for:

- S Low electrical resistivity
- ⊘ Low friction coefficient
- 🔗 Low wear
- Seasy handling during production







Real density 2.27 -2.26 -2.25 -2.24 -2.23 -2.22 -2.22 -2.21 -SLP50 T44 KS44 KC44 SF644

Xylene density (g/cm<sup>3</sup>)



### **TIMREX® SPL50**

The surface area is similar to SFG44, with a very low oil absorption and a low spring-back value which results in the following benefits for carbon brush manufacturers:

- ⊘ Low resin consumption
- Strong mechanical properties
- ⊘ High density



Carbon brushes made with SLP50 have a higher pressed density and a higher in-plane electrical resistivity compared to those with SFG44. These brushes also have the highest mechanical performance.







#### TIMREX<sup>®</sup> C-THERM<sup>™</sup>

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

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





## TIMREX® C-THERM™

Carbon brushes with **C-THERM**<sup>™</sup> have a lower friction coefficient compared to those made with primary synthetic graphites. This results in higher mechanical durability.



Sliding distance (m)



SFG75



C-THERM™





### **ENSACO® CARBON BLACK / COKE**

Our portfolio includes specialty carbon based additives designed for the specific needs of carbon brush formulations:

- Stabilization of friction layer and friction coefficient (fine coke powders, with oversize control).
- Customized level of electrical resistivity values
   (ENSACO<sup>®</sup> electrically conductive carbon black).



Carbon brush (**TIMREX® KS150** and **ENSACO® 250** and 20% wt. resin; pressed at 2 t/cm<sup>2</sup> compacting pressure)

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

### **IMERYS GRAPHITE & CARBON STUDY RESULTS**

### **PRESSED DENSITY VS. GRAPHITE TYPE**

### PRESSED DENSITY VS. PARTICLE SIZE DISTRIBUTION



Pure graphite (pressed at 2.5 t/cm<sup>2</sup> compacting pressure)



Carbon brush (20% wt. resin)



Carbon brush (30% wt. resin, pressed at 2 t/cm<sup>2</sup> compacting pressure)





### **IMERYS GRAPHITE & CARBON STUDY RESULTS**

### SPRING-BACK

Spring-back and compact pressed 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. Spring-back is influenced mainly by compacting pressure, particle size distribution and crystalline structure of graphite. Typically, high crystalline structure results in low spring-back. Compacts produced from powders having a low spring-back can be easily formed and pressed with greater accuracy and density.



### **BENDING STRENGTH**

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







### **IMERYS GRAPHITE & CARBON STUDY RESULTS**

#### **ELECTRICAL RESISTIVITY**

The compressibility of each graphite grade affects the electrical resistivity due to micro-cracks and residual porosity in the carbon brush.

Carbon brush (30% wt. resin pressed at 2 t/cm<sup>2</sup>)



Carbon brush (30% wt. resin pressed at 2 t/cm<sup>2</sup>)



### **ELECTRICAL RESISTIVITY-ANISOTROPY**

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 approximately 6 for KS primary synthetic graphite up to approximately 10 for SFG.

Electrical resistivity anisotropy (through-plain/in-plane electrical resistivity) of carbon brush (20% phenolic resin)





### **TEST METHODS**

#### SAMPLE PREPARATION

The following standard procedure is used to prepare model carbon brushes:

#### Mixing:

Graphite powder is dry mixed with phenolic resin powder (typically 80% wt. graphite with 20% wt. resin or 70% wt. graphite with 30% wt. resin)

#### Compaction:

The mixed powders are pressed into a rectangular mould (either 20x30 mm<sup>2</sup>, 50x12 mm2 or 5x35 mm<sup>2</sup>) at different pressures (from 1 t/cm<sup>2</sup> to 5 t/cm<sup>2</sup>)

#### Curing:

The pressed samples are cured in an oven with thermal treatment:

- 25 to 80°C over 120 minutes
- 80 to 135°C over 660 minutes
- 135 to 180°C over 270 minutes
- It is held at 180°C for 120 minutes
- 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).

### **BENDING STRENGTH**

The transverse rupture strength is measured using a 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 the sample fails.

## \_\_\_\_\_

ELECTRICAL RESISTIVITY

The electrical resistivity is measured using the four-point method both in the in-plane (XY) and through-plane (Z) direction. The four-point method greatly reduces the possibility of error due to poor contacts.











#### SPRING-BACK

To measure the spring back, or 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 ( $p=0.477 \text{ t/cm}^2$ ) and the powder sample thickness is measured. The thickness is measured again after pressure has been released.

### **OIL ABSORPTION**

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

### TRIBOLOGY

Tribology tests are performed on a MCR302 rheometer (Anton Paar) equipped with a tribology cell (T-PTD200). The setup is based on the ball-on-three-plates principle consisting of a shaft, where a ball is held, and an inset where three small plates can be placed. In our case, the three plates are carbon brushes filled with 80% graphite, and an unhardened steel (1.4401) ball is used for our experiments. We perform tests at a constant rotational speed (500 rpm corresponding to 0.235 m/s) and constant normal force (50 N over 10 min) for 10 minutes and measure the mean friction coefficient.









# IMERYS GRAPHITE & CARBON – A STRONG, INNOVATIVE COMPANY.





With production sites in Europe, Canada and Japan and sales offices in Europe, America and throughout Asia we can ensure security of supply and an optimal customer experience.

### **OUR EXPERTISE**

Imerys Graphite & Carbon is a global company focused on delivering carbon based solutions for manufacturing and industry.

We have over 100 years of experience in the development and production of a wide variety of high quality synthetic and natural graphite powders, conductive carbon blacks, silicon carbide and water based dispersions for various end applications including, but not limited to:

- ℅ Lithium-ion Batteries
- ⊘ Alkaline Batteries
- ✓ Lead Acid Batteries
- Solution Conductive Polymers, Plastics and Rubbers
- ⊘ Carbon Brushes
- Solution Brake Pads and Clutches
- Solution Powder Metallurgy and Hard Metals
- **⊘** Refractories

Our team of over 500 experienced professionals ensures we deliver optimal solutions for the technical challenges faced by our customers making us the market leader for:

- Conductive carbon blacks and graphites for lithium-ion batteries
- ♂ Graphites for alkaline batteries
- S Graphites for resin bonded carbon brushes
- Solutive carbon blacks for conductive polymers

#### **IMERYS GROUP**

Imerys Graphite & Carbon belongs to Imerys Group, the world leading supplier in mineral based specialties for industry.

The Group draws on its understanding of applications, technological knowledge and expertise in material science to deliver solutions based on beneficiation of its mineral resources, synthetic minerals and formulations. These contribute essential properties to customers' products and their performance, including heat resistance, hardness, conductivity, opacity, durability, purity, lightness, filtration, absorption and water repellency.

#### EUROPE, AFRICA, MIDDLE EAST, INDIA

Imerys Graphite & Carbon Switzerland Ltd. "Il Centro" Via Cantonale 65, CH-6804 Bironico SWITZERLAND

Tel: +41 91 873 20 10 Fax: +41 91 873 20 19 sales\_gc.emeia@imerys.com

#### AMERICAS

\_\_\_\_

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 sales\_gc.americas@imerys.com

### —

### CHINA

Imerys Graphite & Carbon 1438 Hong Qiao Road, Chang Ning District 6F Gubei International Fortune Centre II CN-201103 Shanghai CHINA

Tel: + 86 21 2223 0136 Fax: + 86 21 2223 0199 sales\_gc.cn@imerys.com

**KOREA & SOUTH EAST ASIA** 

Imerys Graphite & Carbon South Korea 3F, Keumseong Building, 314, Teheran-Ro Gangnam-Gu, KR-06211, Seoul KOREA

Tel: +82 234 88 30 30 Fax: +82 234 74 45 82 sales\_gc.kr@imerys.com

#### **JAPAN & TAIWAN**

Imerys Graphite & Carbon Japan K.K. Shinagawa Seaside South Tower 11F, 4-12-1, Higashi Shinagawa Shinagawa-ku, Tokyo 140-0002 JAPAN

Tel: +81 3 4570 5410 sales\_gc.apac@imerys.com



The information contained herein is believed to be correct. However, no warranty is made, either expressed or implied regarding the accuracy or the results to be obtained from the use of such information. The user assumes all risk and liability for intellectual property infringement and no statement(s) made in relation to this material is intended or shall be construed as inducing infringement of a valid patent.

