SPECIALTY CARBONS FOR THE **POSITIVE ELECTRODE OF LITHIUM-ION BATTERIES**

C-NERGY™ Graphite

C-NERGY™ Conductive Carbon Black

IMERYS

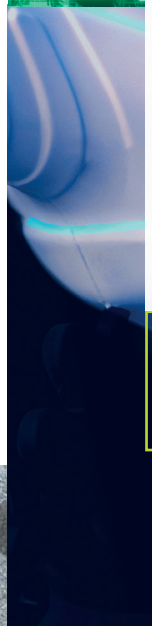
ADVANCED KNOWLEDGE AND EXPERTISE – FOR HIGH QUALITY, HIGH PERFORMING SOLUTIONS

INSPIRED BY THE FUTURE

Inspired by future technologies and combined with the strength of over a century of experience in the development of specialty carbon additives for the most advanced applications, Imerys Graphite & Carbon markets high quality solutions for a wide range of needs.

All of our solutions are developed in close partnership with our customers representing diverse markets. Our particular expertise in the mobile energy market covers lithium-ion batteries, fuel cells, alkaline batteries and lead acid batteries.

A global presence and extensive networks, state-of-the-art laboratories, scientists and technical experts support the continuous development of consistent, high quality products suitable for the most sophisticated applications.



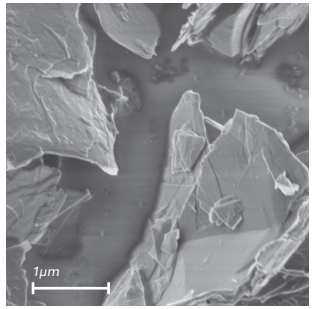
C-NERGY™ GRAPHITE

PERFORMANCE ENHANCING CONDUCTIVE ADDITIVES

C-NERGY™ L -series is a range of specialty synthetic graphites especially designed for positive electrodes of lithium-ion batteries.

Key benefits include:

- Improved safety and lower rejection rate
- Enables the utilization of more economical active materials in the positive electrode
- No additional pre-dispersing unit is required
- No need for a dispersing agent
- Faster electrolyte absorption
- Higher production output



SEM image of KS6L

PRODUCT CHARACTERISTICS

Very High Purity

- Ultra low metal impurities
- Ultra low ionic impurities

Very High Electrical Conductivity

- Extremely high crystallinity
- Very high electrical conductivity

High Density and Low Spring Back

- High electrode density
- High electrode compressibility
- Significantly improved mechanical strength of the electrode

Very Efficient Electrolyte Wettability

- Rapid electrolyte absorption
- High ionic conductivity

APPLICATION BENEFITS

- Increased battery safety
- Lower rejection rate
- Fully compatible with most common electrolyte systems
- High electrode capacity
- High energy density
- High cycling stability
- High power density
- Low dosage required vs conventional graphite grades
- Minimal electrode expansion after pressing
- Improved electrode flexibility
- Facilitates the addition of other conductive additives
- Cost reduction due to faster electrolyte filling step during battery assembly
- Improved battery performance due to more efficient cathode wetting
- Lower dosage required vs conventional graphite grades
- Reduced global additive costs

RECOMMENDED USE

The unique characteristics of **C-NERGY™ L-grades** give unmatched performance improvements in Li-ion batteries.

Recommended C-NERGY™ L-grades dosage in positive active material: 1-3 wt%.

C-NERGY™ L-grades build a graphite matrix that facilitates the addition of other conductive additives.

Better performance is obtained when **C-NERGY™ L-grades** are used in combination with ca. 1 wt% of **C-NERGY™ SUPER C65T** or **C-NERGY™ SUPER C45** carbon black.

TYPICAL PRODUCT PROPERTIES

	SFG6L	KS6L
Ash (%)	0.01	0.01
Fe (ppm)	10	10
Cl^- (ppm)	5	5
SO^{2-}_4 (ppm)**	25	25
Amount of magnetic particles / gram of product****	<1	<1
Time to adsorb DMC electrolyte solvent (msec)*	200	200
In-plane electrical conductivity of LFP electrodes at 2wt% of graphite (mS/cm)**	32	31
In-plane electrical conductivity of NMC electrodes at 2wt% of graphite (mS/cm)**	52	51
Density of LFP electrodes at 2wt% of graphite (g/cm^3)***	2.2	2.2
Density of NMC electrodes at 2WT% of graphite (g/cm^3)***	3.0	3.0
Spring-back (%)	10	12

More data available upon request. *Defined as time it takes to reach a contact angle of 0°. **Measured in presence of 1 wt% of C-NERGY™ SUPER C65, not densified. ***Measured in presence of 1wt% of C-NERGY™ SUPER C65, densified uniaxially at 32 kN/cm^2 ****Based on SEM-EDX method.

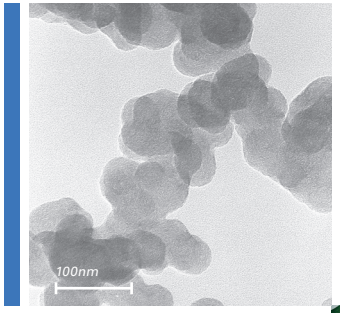
C-NERGY™
CONDUCTIVE CARBON BLACKS

HIGHEST PURITY, HIGHEST PERFORMANCE

C-NERGY™ conductive carbon blacks meet the highest purity requirements making them the ideal additive to give electrical conductivity to lithium-ion batteries with low loadings.

Key benefits include:

- Proprietary production process resulting in the unique combination of high structure and low surface area guaranteeing exceptional distribution in electrode slurries
- Low moisture pick up
- Highly graphitic ensuring excellent system stability
- Reduction in OCV (open circuit voltage), which reduces rejection rate and improves safety

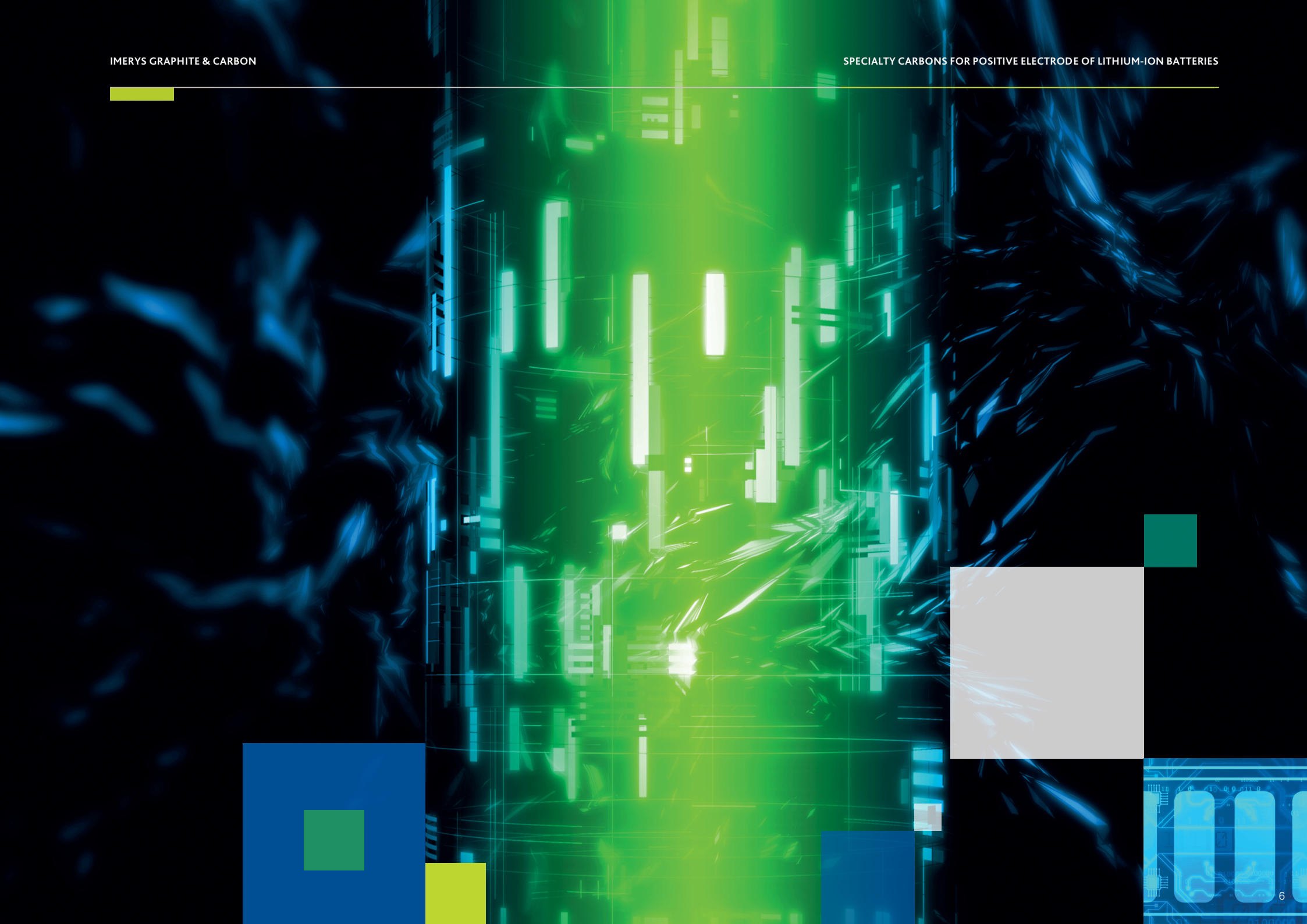


SEM image of carbon black

PROPERTIES OF IMERYS GRAPHITE & CARBON HIGH PURITY CARBON BLACKS

PROPERTIES	UNITS	SUPER P®Li	C-NERGY™ SUPER C65	C-NERGY™ SUPER C65T	C-NERGY™ SUPER C45
Absorption stiffness value	ml/5g	32	32	32	36
BET surface area	m^2/g	62	62	62	45
Ash content*	%	0.05 max	0.025 max	0.025 max	0.025 max
Grit 45 µm / 325 mesh	ppm	<2	<2	<2	<2
Grit 20 µm / 625 mesh	ppm	12	12	5	12
Ferrous & non-ferrous particles**	pp/150g	–	–	40	–
Iron particles**	pp/150g	–	–	25	–
Iron	ppm	5	2	1.5	2
Nickel	ppm	1	1	0.5	<1

* Ash content, iron particles and ferrous & non-ferrous particles are all guaranteed values. All others are typical values. ** Based on hybrid XRF method.

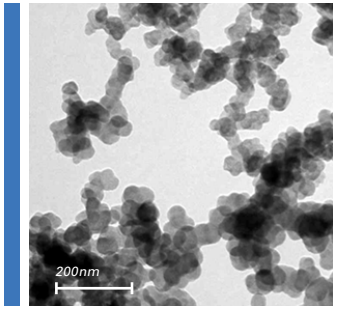


C-NERGY™ SUPER C65T

METALLIC IMPURITIES DETECTED BY XRF IN 150G C-NERGY™ SUPER C65T (EXAMPLES).

SPECIES	C-NERGY™ SUPER C65T
Fe	10
FeZn	0
FeCu	0
FeCuZn	0
FeCr	1
Fe + alloys	8
Cu	0
Zn	0
Zn + alloys	1
CuZn	0
Ti	0
Mn	0
Co	0

* The reported values are given as an example.



SEM image of C-NERGY™ SUPER C65T

Imerys Graphite & Carbon high purity carbon blacks show the same percolation behaviour in powder mixtures (Fig. 1a). Fig. 1b demonstrates improved rheology compared to the competitors carbon black.

Fig 1a

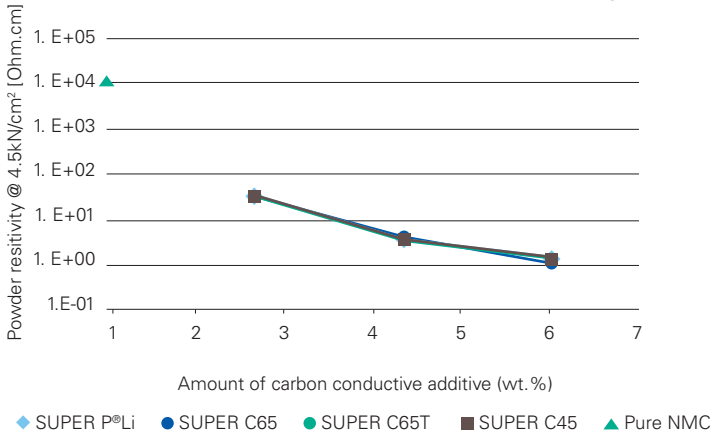
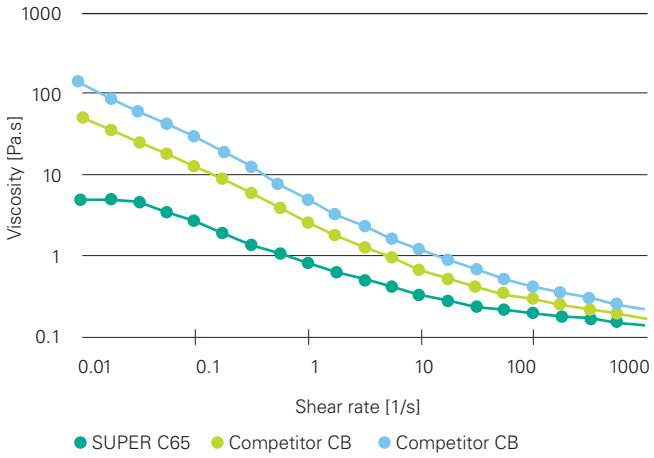
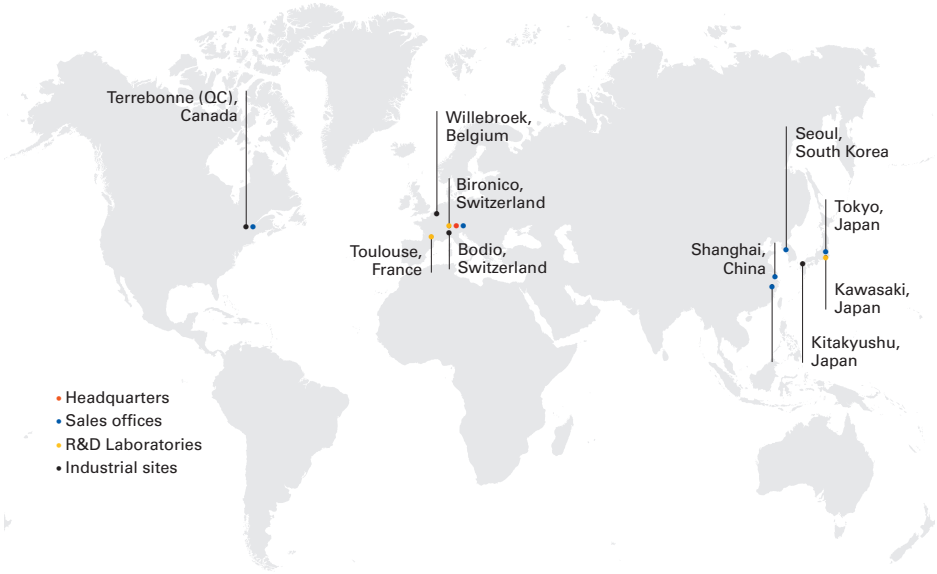


Fig 1b



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
- Fuel Cells
- Conductive Polymers, Plastics and Rubbers
- Carbon Brushes
- Brake Pads and Clutches
- 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
- Graphites for resin bonded carbon brushes
- Conductive 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.

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