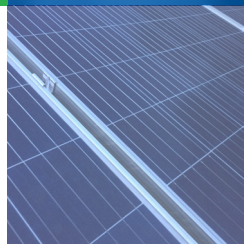


SPECIALTY CARBONS FOR THE NEGATIVE ELECTRODE OF LITHIUM-ION BATTERIES

C-ENERGY™
Graphite

C-ENERGY™
Conductive
Carbon Black





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-ENERGY™ GRAPHITE

PERFORMANCE ENHANCING CONDUCTIVE ADDITIVES

C-ENERGY™ L-series is a range of specialty graphites especially designed for negative electrodes of lithium-ion batteries.

Key benefits include:

- ✓ Enables the utilization of more economical active materials in the negative electrode
- ✓ Enables reduced electrochemical inactive components dosage in the negative electrode
- ✓ Reduction of global additives cost (in negative and in positive electrode)
- ✓ No additional pre-dispersing unit is required
- ✓ No need for a dispersing agent
- ✓ Faster electrolyte absorption
- ✓ Higher production output

PRODUCT CHARACTERISTICS



Very High Purity

- ✓ Ultra low metal impurities
- ✓ Ultra low ionic impurities



Very High Electrical Conductivity and Reversible Capacity

- ✓ Extremely high crystallinity
- ✓ Very high electrical conductivity
- ✓ Extremely high reversible capacity



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
- ✓ Extremely high reversible capacity

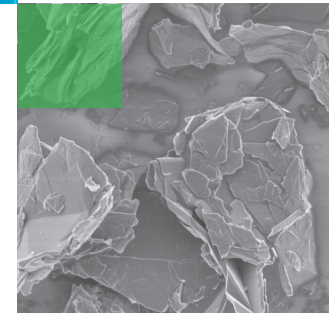
APPLICATION BENEFITS

- ✓ Increased battery safety
- ✓ Lower rejection rate
- ✓ Fully compatible with most common electrolyte systems

- ✓ High energy density
- ✓ Extremely high cycling stability
- ✓ High charge acceptance
- ✓ Low dosage required vs conventional graphite grades
- ✓ Reduced global additives costs

- ✓ Minimal electrode expansion after pressing
- ✓ Improved electrode flexibility
- ✓ Facilitates the addition of other conductive additives

- ✓ Cost reduction due to faster dispersion in water based electrode slurry
- ✓ Cost reduction due to a faster electrolyte filling step in battery assembly
- ✓ Improved battery performance due to more efficient anode wetting



RECOMMENDED USE

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

Recommended C-ENERGY™ L-grades dosage in negative active material: 1-8 wt%.

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

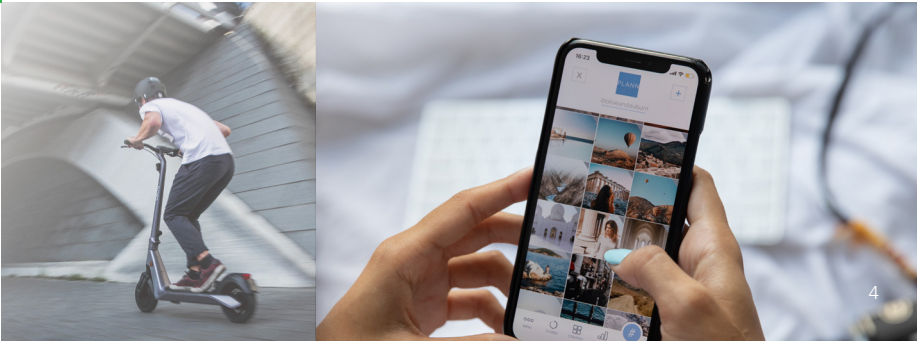
Better performance is obtained when C-ENERGY™ L-grades are used in combination with ca. 1 wt% of C-ENERGY™ SUPER C65T or C-ENERGY™ SUPER C45 carbon black.



TYPICAL PRODUCT PROPERTIES

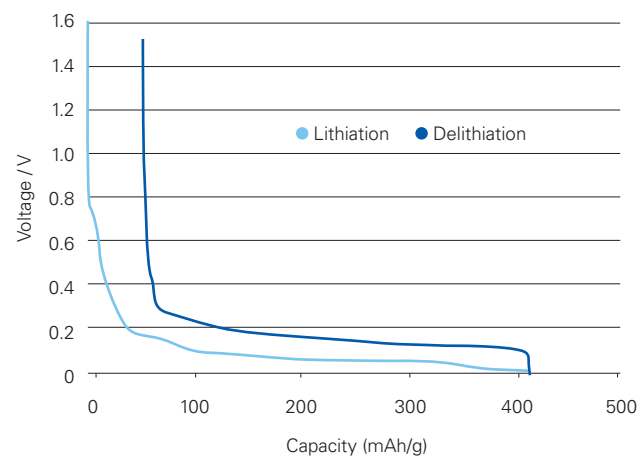
	ASH (%)	FE (PPM)	Cl ⁻ (PPM)	SO ₄ ²⁻ (PPM)	AMOUNT OF MAGNETIC PARTICLES / GRAM OF PRODUCT*	TIME TO ABSORB DMC ELECTROLYTE SOLVENT (msec) ¹	TIME TO ABSORB WATER (msec) ¹	ELECTRODE DENSITY (g/cm ³)	SPRING- BACK (%)	REVERSIBLE CAPACITY (Ah/kg)
SFG15L	0.01	10	5	25	<1	100	300	>1.75	10	365
KS15L	0.01	10	5	25	<1	200	400	>1.75	13	335

More data available upon request. 1) Defined as time it takes to reach a contact angle of 0° * Based on SEM-EDX method.

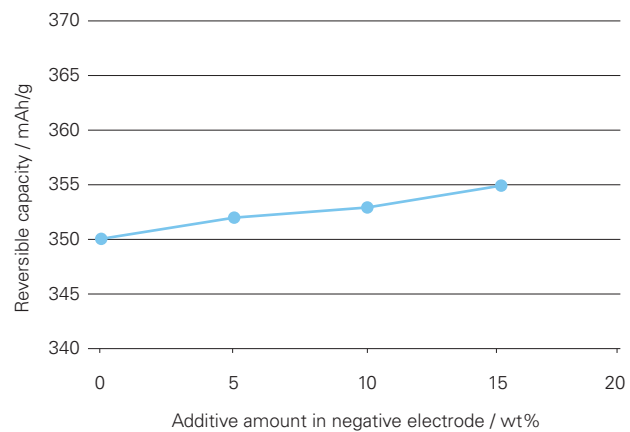


C-ENERGY™ GRAPHITE

Typical potential profile for C-ENERGY™ SFG15L during the first cycle in the range 0.005-1.5V vs. Li⁺/Li.



Example of reversible capacity contribution of C-ENERGY™ SFG15L at different amounts in the negative electrode formulation.





C-ENERGY™ CARBON BLACK

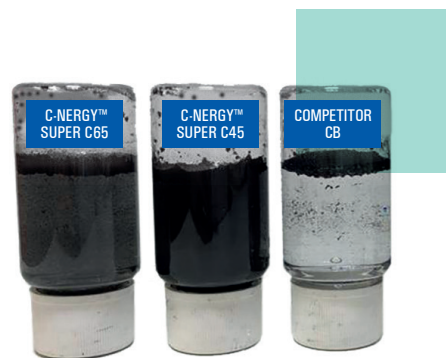
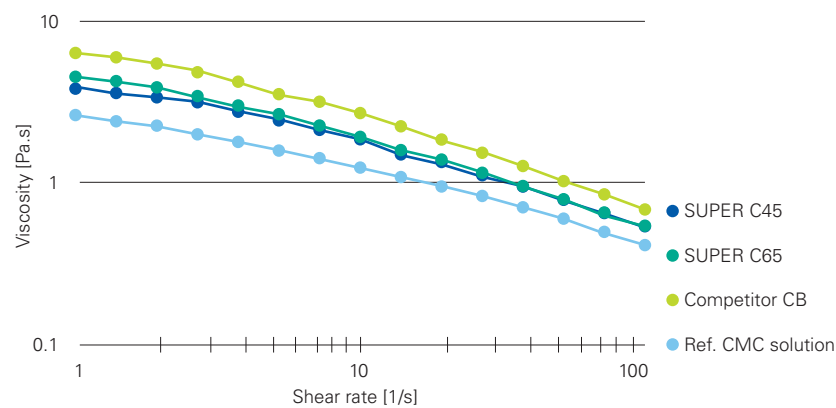
HIGH PURITY, HIGH PERFORMANCE

C-ENERGY™ 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

Improved rheology compared to the competitor's carbon black in aqueous based slurries



PROPERTIES OF IMERYS GRAPHITE & CARBON HIGH PURITY CARBON BLACKS

PROPERTIES	UNITS	SUPER P® Li	C-ENERGY™ SUPER C65	C-ENERGY™ SUPER C65T	C-ENERGY™ 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.

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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