



ADITYA BIRLA



BIRLA CARBON

# CONDUCTEX™ e

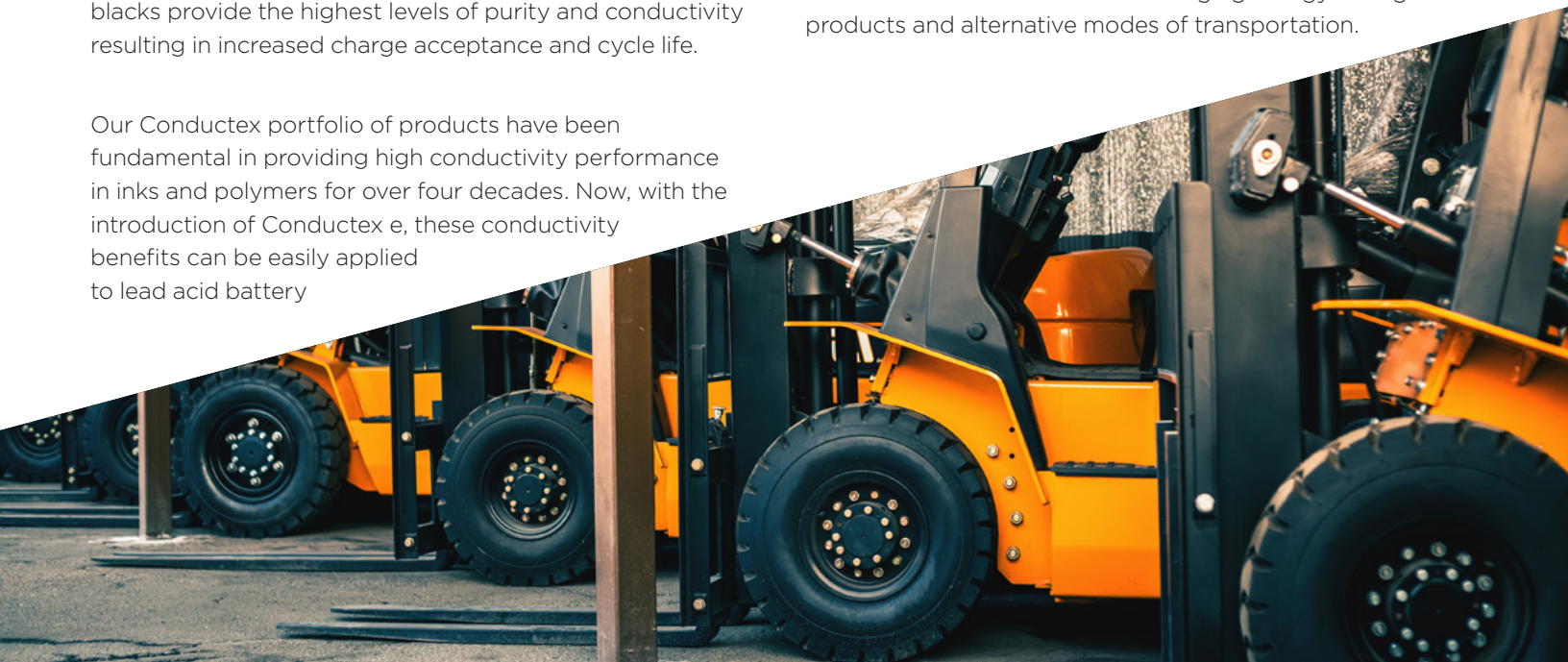
Specialty Blacks for Advanced Lead Acid Batteries

Lead acid batteries are the world's most widely produced and recycled battery technology with over 98% of all automotive vehicles including electric vehicles and 70% of world wide energy storage systems relying on this mature technology. With the huge, anticipated demand for more installed battery capacity in the future, both lithium ion and lead acid batteries will play substantial roles in closing the demand gap in a variety of markets. In all of these lead acid battery applications there is a need for high performance that is enabled by conductive carbons such as carbon black. Birla Carbon's new Conductex e conductive carbons are designed specifically for the lead acid battery market enabling our worldwide partners customizable formulations and performance in a variety of sectors, including automotive, telecom, motive power, energy storage systems, and e-bikes. By leveraging our specially developed Ultra process, Conductex e carbon blacks provide the highest levels of purity and conductivity resulting in increased charge acceptance and cycle life.

Our Conductex portfolio of products have been fundamental in providing high conductivity performance in inks and polymers for over four decades. Now, with the introduction of Conductex e, these conductivity benefits can be easily applied to lead acid battery

applications demonstrating Birla Carbon's commitment to renewable and sustainable energy. With research facilities on both sides of the globe, a worldwide distribution network, and a commitment to consistent quality, Birla Carbon is poised to be the preferred supplier, offering a deep and wide portfolio of solutions to meet advanced lead acid battery needs.

Today, Birla Carbon provides carbon blacks in a wide range of particle size and conductivity offering our global partners incomparable flexibility and consistency. We continue to be a partner in innovation to create and develop high performance solutions to allow lead acid batteries to remain a reliable energy storage solution. Our researchers are continually exploring advancements in lead acid battery formulations to make them more efficient to meet the needs of emerging energy storage products and alternative modes of transportation.



Birla Carbon is the world's largest manufacturer and supplier of carbon black, capable of producing more than 2 million mt each year. As a flagship business of the Aditya Birla Group, our facilities are spread across five continents and 12 countries consisting of 16 manufacturing units, 2 regional technical service centers, and 2 technology centers. Our presence in each of the key markets of Asia, Europe, and the Americas enables us to deliver consistent, high-quality products and services worldwide. With our portfolio of more than 100 types of carbon black, we provide solutions to leading companies in the rubber and specialty applications segments.

The Birla Carbon business focuses on rubber, tires, plastics, inks, energy systems, and other markets. Our **Raven** and **Conductex** carbon blacks meet every requirement in these markets and provide

the desired properties of purity, color, conductivity, viscosity, and UV protection for a wide range of applications.

Our contemporary research infrastructure and state-of-the-art technology centers make us well equipped to collaborate with our customers and provide the best possible solution to any challenge.

#### **FOCUSING ON SUSTAINABLE OPERATIONAL EXCELLENCE**

Through our implementation of Sustainable Operational Excellence, we optimize the way we make carbon black, minimize our environmental footprint, and make valuable contributions to our communities and society as a whole. We strive to fulfill our commitment to reduce the environmental and social impact of our products, while ensuring world-class quality and supply continuity for our customers.



# FUNDAMENTAL PROPERTIES OF CARBON BLACK

The performance of carbon black is determined by its fundamental properties and the degree of dispersion which can be achieved in the final application. The most important physical and chemical properties include particle size, structure, surface chemistry, and microstructure. The level of carbon black dispersion which can be achieved in a mixed system depends strongly on the mixing equipment, formulation (including organic additives), and physical form.

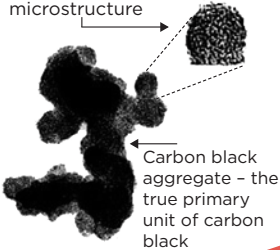
**PARTICLE SIZE** is the primary influence on the amount of active surface area and can be measured using electron microscopy or nitrogen adsorption methods. Smaller particles result in higher conductivity, increased low temperature discharge performance, and dynamic charge acceptance for lead acid batteries. These benefits are often offset by increased water loss and difficulty in dispersion leading to inconsistent performance.




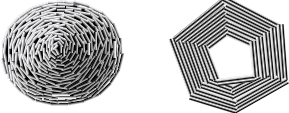
**STRUCTURE** is a measure of the degree of branching that occurs due to the fused three-dimensional nature carbon black forms during production. This branched structure allows the carbon black to better absorb liquids during pasting and cycling and is measured using the oil adsorption number (OAN). Increased structure can increase the conductivity by providing an electrical network while increasing the dispersibility in the paste. This increased branching can also lead to an increase in paste viscosity and may require additional water.

**SURFACE CHEMISTRY** can be carefully tailored to provide surface functional groups that impact the wettability, dispersion, rheology, and conductivity properties of the carbon black. Various oxygen containing functional groups increase the hydrophilicity but decrease the conductivity of the resulting product. The extent of surface oxidation is determined by the quantity of volatile species present and higher levels result in lower pH.

**MICROSTRUCTURE** is determined by the degree of order or crystallinity present in the carbon black which increases with the size and amount of ordered carbon. Ordered carbon has increased electrical conductivity and purity which improves high-rate performance and reduces water loss and gassing.

Carbon black particle showing paracrystalline microstructure



PROPERTY	INFLUENCE OF PROPERTY ON PERFORMANCE
<p>Particle Size Distribution</p> 	<p>Smaller Particle Size (Higher Surface Area)</p> <ul style="list-style-type: none"> <li>Increases conductivity</li> <li>Increases cold cranking power</li> <li>Increases dynamic charge acceptance</li> <li>Increases gassing and water loss</li> <li>Reduces dispersibility</li> <li>Increases partial state of charge cycle life</li> </ul>
<p>Structure - Aggregate Size/ Shape Distribution</p> 	<p>Higher Structure (Increasing Oil Absorption)</p> <ul style="list-style-type: none"> <li>Increases conductivity</li> <li>Improves dispersibility</li> <li>Increases paste viscosity</li> <li>Increases formation efficiency</li> </ul>
<p>Surface Chemistry</p> 	<p>Higher Surface Functionality (Lower pH)</p> <ul style="list-style-type: none"> <li>Improves paste wetting and uniformity</li> <li>Increases water retention</li> <li>Lowers electrical conductivity</li> </ul>
<p>Microstructure – Crystallite Size</p> 	<p>Higher Crystallinity (Larger Crystalline Domains)</p> <ul style="list-style-type: none"> <li>Improves conductivity</li> <li>Increases purity</li> <li>Decreases dispersibility</li> </ul>

**Additional Properties:** Other Constituents: Ash and Metals, Sulfur, Residue | Physical Form: Beads/Granules or Powder

## DRIVEN PERFORMANCE



### CHARGE ACCEPTANCE

Our Conductex e line of conductive carbon blacks provide high conductivity and a morphology tailored to enable the fast-recharging performance required of start-stop and micro-hybrid applications. This performance is critical for meeting the sustainability goals and fuel savings targets of many automotive manufacturers.



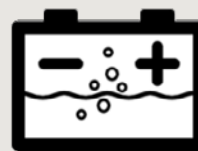
### COLD CRANKING POWER

Our conductive carbon additives are designed to provide a robust electrical network which allows advanced lead acid batteries to meet their power requirements in extreme cold temperatures necessary for automotive and e-bike applications while maintaining battery durability.



### CYCLE LIFE

Our Conductex e performance carbon blacks have high purity and tailored surface chemistry which deliver consistent battery performance even during deep cycle as well as partial state of charge operation. This extends the product lifetime and reduces overall cost of ownership making a more sustainable product possible.



### GASSING AND WATER LOSS

Our Conductex e line of carbon black conductive additives have a tailored particle morphology and high purity which reduces the side reactions that cause gassing and water loss. This reduction of water loss helps both flooded and valve regulated batteries and can increase the battery lifetime while lowering maintenance requirements.



### DISPERSIBILITY

Our selection of performance conductive carbons is designed to easily be incorporated into the paste mix using simple dry mixing or pre-wetting methods without the need for pre-dispersed liquid systems. This allows better use of the active material through a robust conductive network and increases the overall battery performance and reliability.

# LEAD ACID BATTERY APPLICATIONS

Birla Carbon now offers a complete portfolio of Conductex e carbon black conductive additives for lead acid battery negative electrodes to enable battery manufacturers to meet the growing charge acceptance, cycle life, and water loss needs of consumers. These products provide the required conductivity and purity levels while providing manufacturers the formulation flexibility required to meet sustainability targets in a variety of lead acid battery sectors, including automotive, telecom, motive power, energy storage systems, and e-bikes. Conductex e10 additive can also be used as a drop-in replacement for acetylene black in the lead acid negative paste mix.

## STARTING LIGHTING AND IGNITION

Low temperatures can sometimes reduce the power available from a lead acid battery to start the engine or run the auxiliary electrical systems required to operate the vehicle. The distinctive morphology and purity of Birla Carbon's Conductex e89 additive provides critical cold cranking performance while optimizing the battery cost and processability. Conductex e50 additives can reduce water loss resulting in longer cycle life and maintenance free operation over the battery lifetime.

## MICROHYBRID AND START-STOP

Stringent CO<sub>2</sub> emission requirements have driven adoption of micro-hybrid and start-stop technologies which rely on partial state of charge operation and charge acceptance to deliver substantial automotive fuel savings. Conductex e10 and e47 additives excel



in both enhanced flooded batteries (EFB) and valve regulated lead acid (VRLA) by providing cost efficient solutions while retaining low temperature performance. Conductex e68 additive is recommended for EFB applications requiring additional partial state of charge performance.

## MOTIVE POWER, ENERGY STORAGE SYSTEMS AND TELECOM

Conductex e31 and e43 additives offer increased conductivity and purity which reduce the required maintenance of these systems in addition to the benefits of long cycle life and deep discharge operation.

## ELECTRIC VEHICLE AND E-BIKE

As the world continues to focus on decarbonization, lead acid batteries continue to play an important role in mobility solutions in rapidly growing markets including China and India. Birla Carbon's Conductex e31 and e43 additives enable high performance and low-cost lead acid batteries with excellent low temperature performance and cycle life under deep or partial discharge. For extra low temperature performance Conductex e89 additive is recommended.

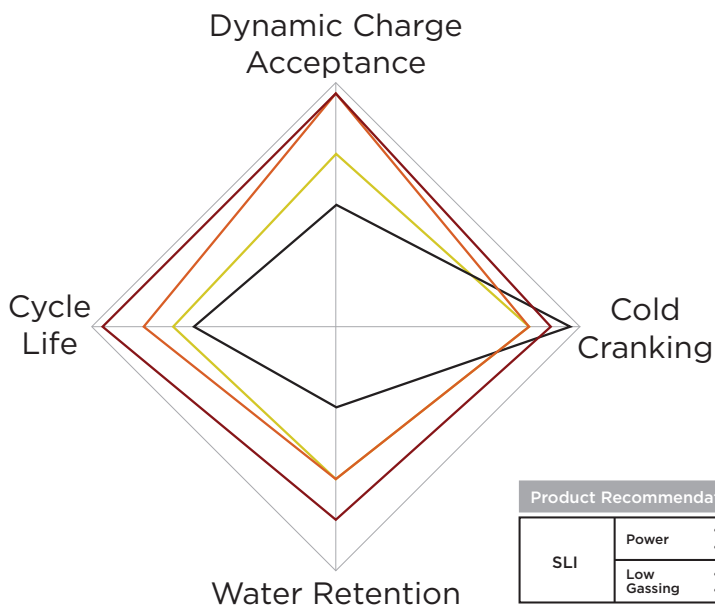


# PRODUCT RECOMMENDATIONS

Conductex e carbon blacks have been specifically designed for use in a wide variety of advanced lead acid battery sectors including automotive, stationary energy storage, e-bike, and forklift applications.

Our unique Conductex e product portfolio offers the benefits of:

- Increased dynamic charge acceptance (DCA)
- Extremely high purity which meets or exceeds the rigorous requirements of lead acid battery applications
- Increased cycle life during partial state of charge (PSoC) operation and lower water loss
- Global availability and consistency for repeatable battery manufacturing
- Wide range of properties which enables formulation flexibility
- Ease of dispersibility enabling repeatable paste mix performance



Product Recommendation		
SLI	Power	• e50 • e89
	Low Gassing	• e15 • e31
Start-Stop	Charge Acceptance	• e15 • e47
	Cycle Life	• e68
Micro-Hybrid	Power	• e10 • e15
	Cycle Life	• e47 • e68
E-bike/ Forklift	Deep Cycle	• e31 • e43
	Low Temp.	• e89

The Birla Carbon team will collaborate with you to find the best possible solution for your carbon black needs. Please contact us at [EnergySystems@adityabirla.com](mailto:EnergySystems@adityabirla.com) to request additional information.

## Conductex e Product Typical Properties

	NSA (m <sup>2</sup> /g)	OAN (cm <sup>3</sup> /100g)	Ash (wt%)	Fe (ppm)	Battery Sectors
Conductex e10	55-60	180-220	< 0.1	< 50	Automotive, EFB/VRLA, Micro-hybrid, Start-stop
Conductex e15	70-80	60-80	< 0.15	< 20	High performance SLI, Automotive EFB/VRLA, Micro-hybrid, Start-stop
Conductex e31	30-40	110-130	< 0.1	< 20	Automotive SLI, e-Bike, Energy storage systems, Telecom
Conductex e43	25-35	60-80	< 0.25	< 30	Forklift, e-Bike, ESS, Telecom
Conductex e47	70-80	130-150	< 0.1	< 20	Automotive, EFB/VRLA, Start-stop, Micro-hybrid
Conductex e50	100-120	100-130	< 0.1	< 20	Automotive SLI, Start-stop
Conductex e68	30-40	120-150	< 0.2	< 20	Automotive EFB/VRLA, Start-stop, Micro-hybrid
Conductex e89	175-195	130-150	< 0.1	< 30	High performance SLI, e-Bike

Data in the table above represents typical values.

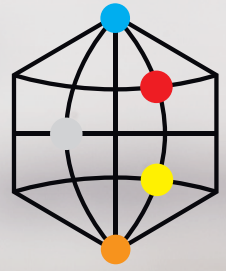
## ABOUT BIRLA CARBON

At Birla Carbon, we've been sharing our knowledge for over a century, forging new pathways and finding new solutions. From learning the true structure of carbon black through the lens of an electron microscope, to sharing best practices around the globe, we push beyond the known to create new techniques and applications. We work with each other, for each other, creating value for our customers by being a partner of value. As a family, we take a generational view, making decisions for the long-term, our gaze just past the horizon.

As an ardent practitioner of sustainable development, Birla Carbon's Sustainable Operational Excellence (SOE) strategy

focuses on employee safety, environmental stewardship, efficient use of carbon sources and a key focus on conducting operations in a socially and ethically responsible manner. In 2021, Birla Carbon was awarded a Gold level rating for sustainable practices for the fifth consecutive year by Ecovadis.

Birla Carbon's Purpose, Share the Strength, is about balanced and shared leadership, working at the product level to innovate cutting edge solutions, through collaboration with its people, customers and communities and backed by knowledge built over a century.



## SHARE THE STRENGTH

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