CABOT

SPECIALTY CARBON BLACKS

HIGH PERFORMANCE MATERIALS
FOR ADVANCED LITHIUM-ION BATTERIES

Introduction

Cabot Corporation is a global performance materials company and we strive to be our customers' commercial partner of choice. We have been a leading manufacturer of carbon black and other specialty chemicals for more than 135 years, and our global reach enables us to partner closely with customers to meet the highest standards for performance, quality, innovation and service. We are a key player in the provision of high performance materials and technology to many sectors of the energy. We have 45 global manufacturing locations, including sites throughout the Asia-Pacific region.

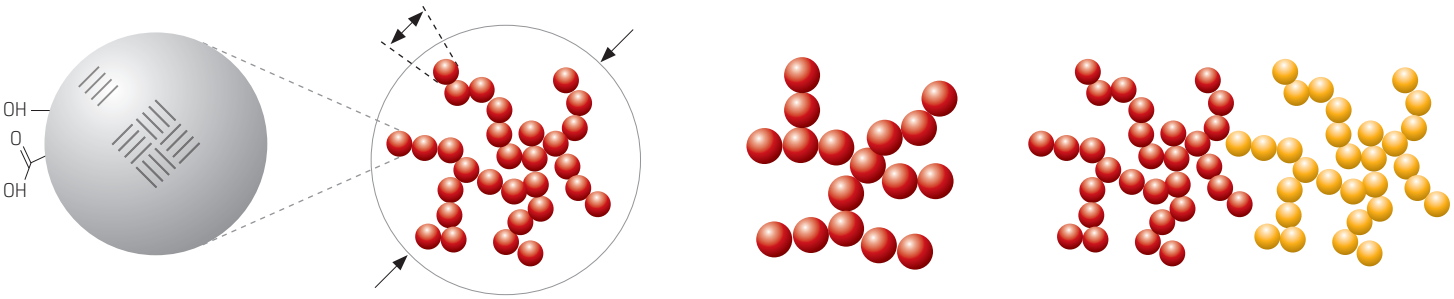
Delivering battery performance through particle science expertise

As demands on battery manufacturers grow with the increased use of advanced batteries in the automotive industry and storage of electricity on the grid, battery manufacturers are looking to performance materials companies like us to enable the next generation of lithium-ion batteries.

We bring unparalleled scale and technological depth when assisting our customers with a broad range of carbon and other particulate materials, such as metal oxides and composites. Our capabilities span the entire range of carbon particle size, morphology and surface properties desired by battery manufacturers and include the ability to control key properties independently, allowing our products to provide the specific functional properties valued in the customer's application.

Figure 1: Our precisely engineered specialty carbon additives offer a broad range of particle size, morphology and surface properties that deliver specific functionality.

Particle



Property	Function
Conductivity	Electrical conductivity, ionic conductivity, thermal conductivity, charge storage, contact resistance, insulating
Rheological	Dispersion, paste viscosity and solid loading, binder interaction, electrolyte storage capacity, thickening efficiency
Mechanical	Electrode density, flexibility, compressibility, adhesion, hardness, stiffness, separator stability and porosity
Surface properties	Moisture adsorption, adhesion, oxidation stability, inertness, electrolyte stability, electrolyte storage capacity

Attribute
Particle size
Aggregate size
Pore structure
Surface chemistry
Surface graphitization

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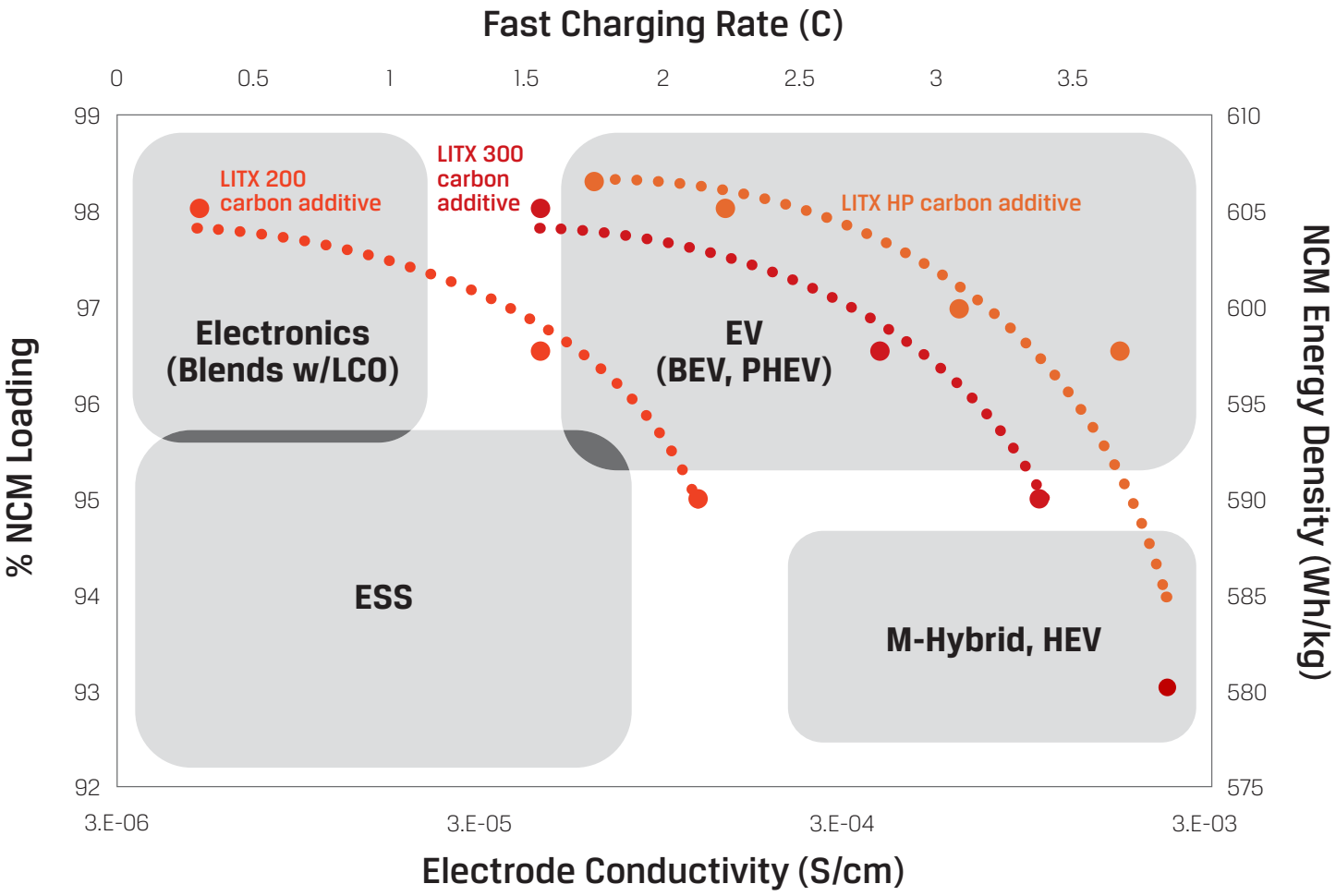
Lithium-ion batteries

With the growth in applications for lithium-ion technology, including electric and hybrid electric vehicles and potentially for the storage of electricity on the grid, there is an increasing demand for new batteries that deliver both high power and high energy storage capability over their lifetime without a decline in performance and without compromising safety. We believe there is tremendous potential to extract greater performance from lithium-ion battery chemistries through innovation and optimization of conductive carbon additives. Conductivity is one of the most important factors affecting the performance of lithium-ion batteries, and battery manufacturers use carbon additives in the electrodes to improve conductivity, particularly in the cathode.

Our LITX® conductive carbon additives are specifically designed for the lithium-ion battery industry and are suitable for use in automotive, electronics, power tool and grid storage applications. Compared to conventional carbon additives, our LITX products have unique properties for battery applications that can enable:

- Faster charging capability
- Improved low-T performance
- Higher energy density
- Easier processing with good dispersibility
- Reduced cost of ownership with lower additive loading and easy processing



Our LITX® family of products can be an excellent choice for battery designers that are trying to achieve higher capacity and improved rate capabilities with reduced cell resistance. Both LITX 300 and LITX HP carbon additives offer great electrical conductivity at low loadings. As shown in Figure 2, both LITX carbon additives can enable improved discharge capacities with reduced DCIR at low SOC than the standard carbon additive; LITX HP carbon additive provides the best performance. LITX products may also enable longer cycle life (as shown in Figure 3), especially for battery designs that operate at high temperatures. LITX products are more compressible than standard carbon additives. This enables denser electrodes along with easier calendering, leading to better adhesion and a reduced amount of binder, resulting in improved energy density.

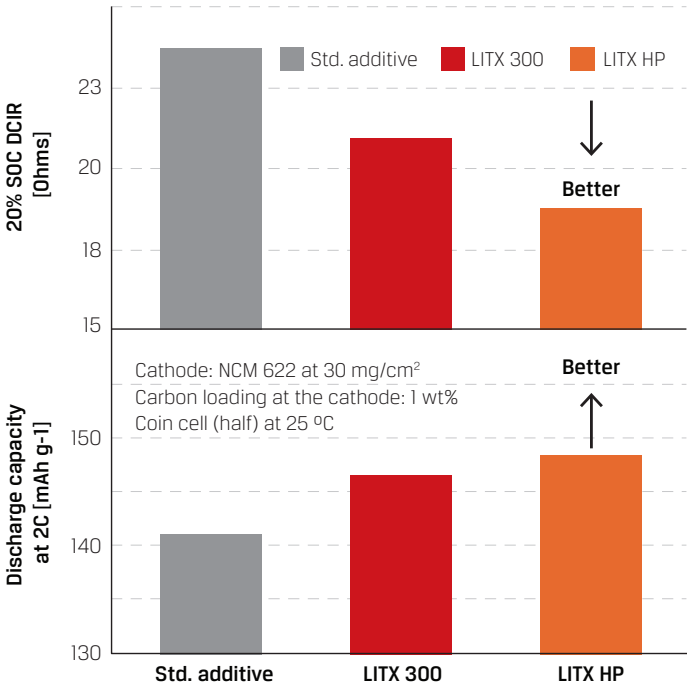


Figure 2: LITX products enable higher discharge capacity with reduced DCIR at low SOC

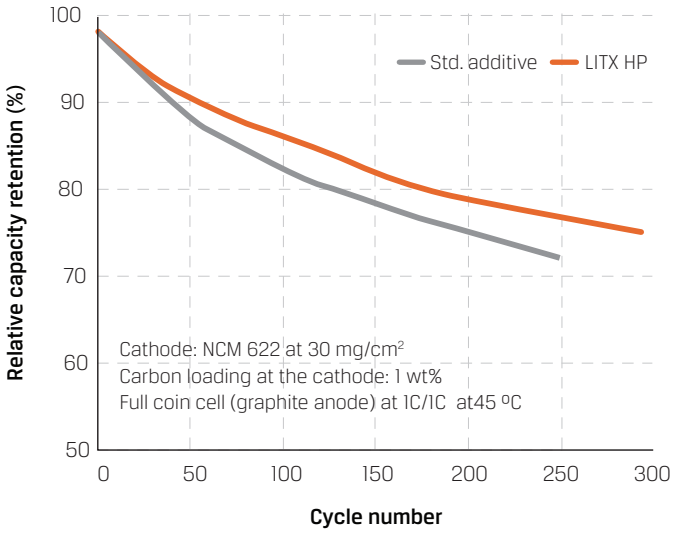
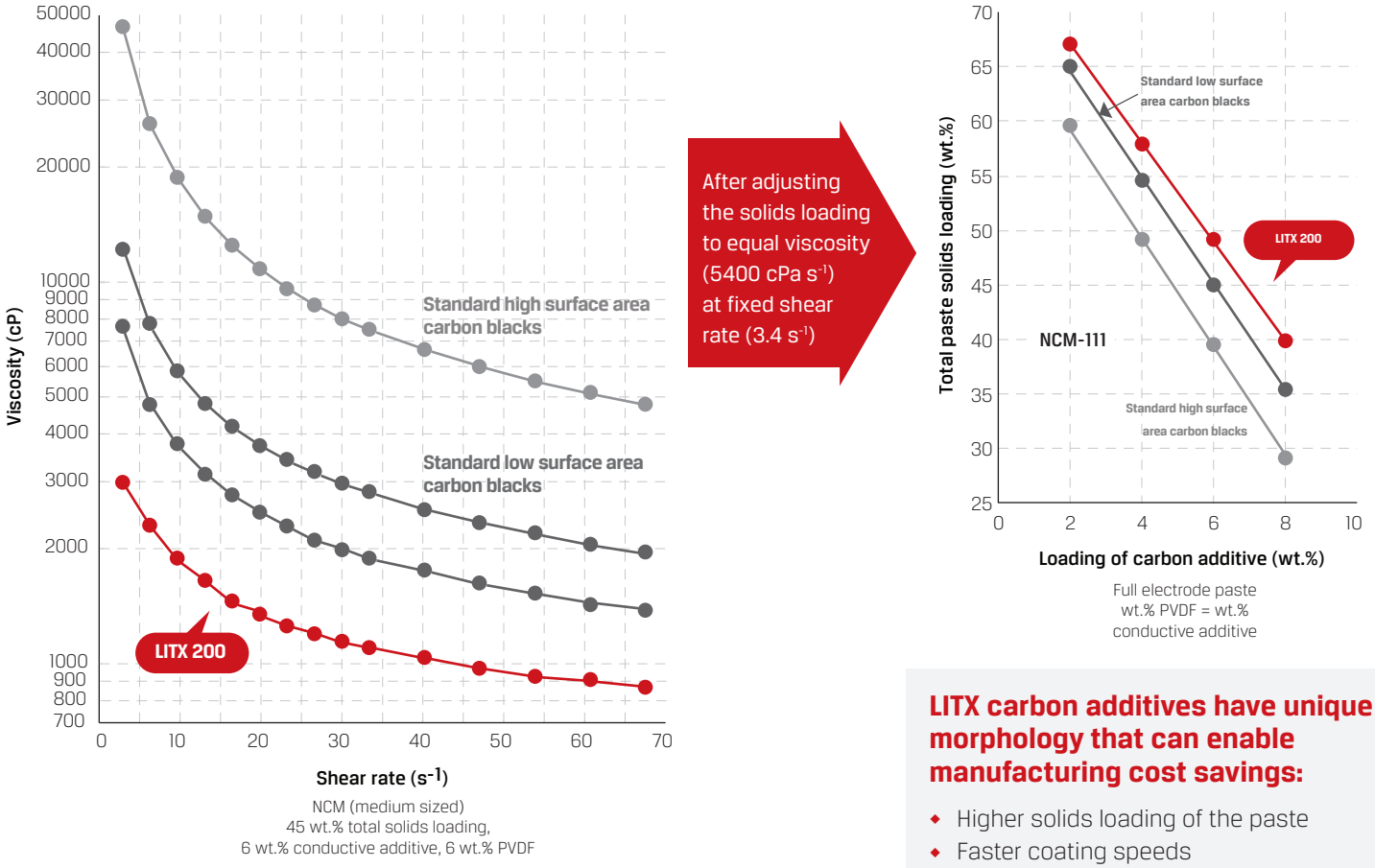


Figure 3: LITX products can improve cycle life especially at high temperatures

Lithium-ion batteries (continued)

In addition to having a positive impact on battery performance, LITX® products can also significantly speed up the electrode coating process, resulting in cost savings, as shown in Figure 4. Because of the unique morphology of LITX products, they demand less solvent in paste preparation which can result in increased solid loading and a higher production rate because of faster coating speeds. Additional benefits are cost reduction and reduced environmental impact because less solvent is used in the electrode coating process.



LITX carbon additives have unique morphology that can enable manufacturing cost savings:

- Higher solids loading of the paste
- Faster coating speeds
- Less NMP required

Figure 4: LITX carbon additives enable processing benefits that can result in manufacturing cost savings

Because of their unique surface properties, LITX® products are easily dispersible in different types of solvent and water-based slurries used for electrode coating. Water-based slurries are particularly challenging because most carbon additives are hydrophobic and difficult to disperse in water. As shown in Figure 5, LITX 200 carbon additive exhibits some unique advantages in water-based slurries in terms of both the ease and uniformity of dispersion, resulting in lower slurry viscosity, which can improve battery performance and reduce the cost of materials and processing.

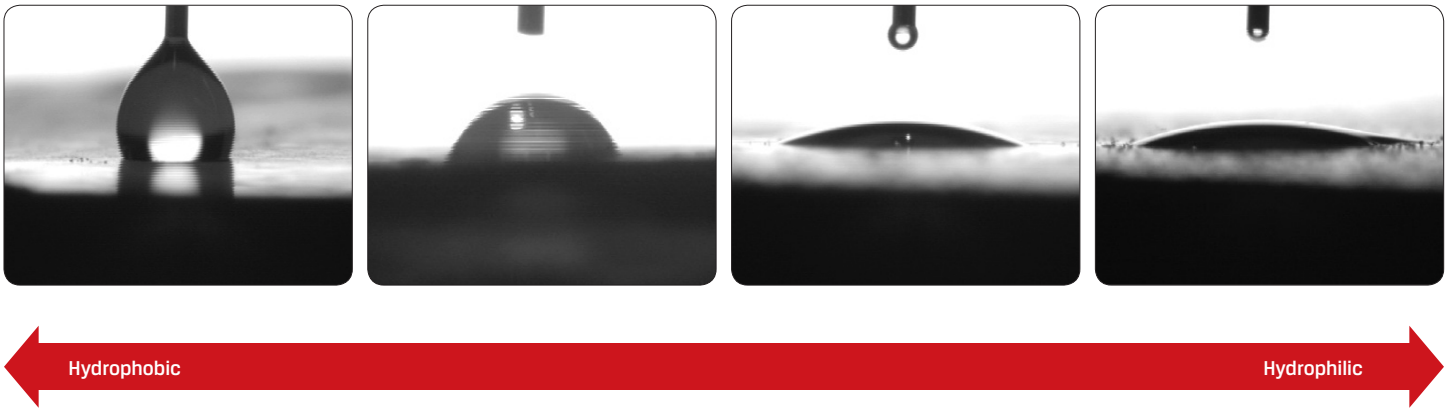


Figure 5: LITX 200 carbon additive offers rheological (viscosity) benefits in aqueous slurries

Our commitment to energy

The world depends upon energy to drive industry, support commerce and care for communities. The world's energy consumption continues to increase, despite planned energy saving initiatives. Satisfying this demand while also striving for a sustainable environment will require not only reliable and safe energy production and distribution from today's technology, but novel solutions to enhance our power generation, storage, transmission and consumption for the future.

We are committed to supporting that goal and we maintain development programs with industry bodies, institutes and universities across the world. We will continue to our expertise in small particle science to deliver solutions that meet the energy needs of today and the challenges of tomorrow.

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