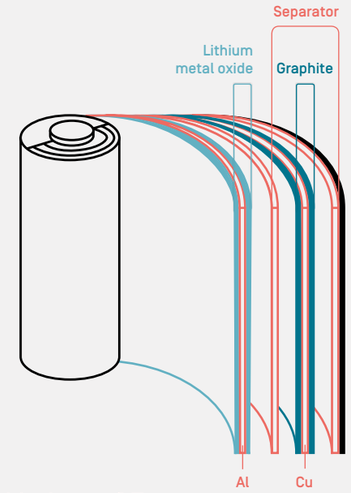
Layers that Power the World

Whether an electric car, smartphone or laptop: **lithium-ion batteries** are usually what supplies us with power. In order to get the maximum performance out of every battery, SGL Carbon researches how all the components interact—and offers high-quality and precisely customized graphite anode materials for every field of application.



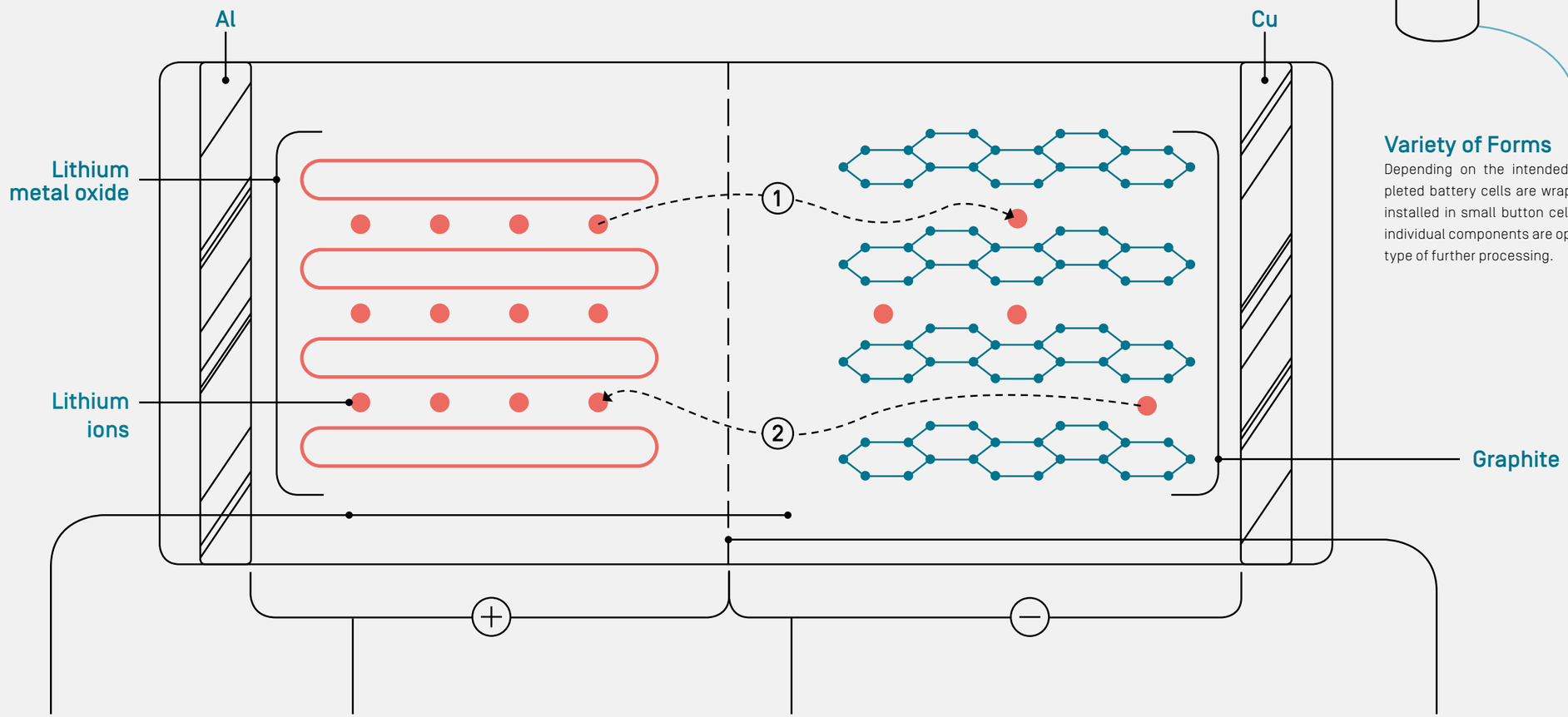
Variety of Forms

Depending on the intended use, the completed battery cells are wrapped, stacked or installed in small button cells. The battery's individual components are optimized for each type of further processing.

Lithium ion batteries function according to a simple principle: when charging, (1) lithium ions migrate from their "home," the lithium metal oxide-based cathode, to their "vacation home," the graphite-based anode. When the battery is discharged, (2) they move back again and release energy. The electrolyte is the "street" the ions are traveling on. But why do the ions migrate? The voltage applied creates an excess of electrons at the anode, which attracts the positively charged lithium ions. As soon as they arrive at the anode, they take up the excess electrons, thereby bringing about a new equilibrium. During discharge the anode releases electrons, which then flow to the cathode via the outer circuit. This releases the energy again.

Lithium is the material of choice for batteries because it's the lightest metal on the Periodic Table—weighing about half as much as water. Furthermore, because of its high electrode potential. This allows the cell voltage to be maximized while minimizing the battery's weight.

The individual components of the lithium ion battery have been continually improved over the years. These improvements include a significant increase to the batteries' capacity. While the first commercial column-shaped battery type (technically called "18650" due to its dimensions) had a capacity of 1,200 mAh at the beginning of the nineties, the same battery now has a capacity of 3,400 mAh. In the Tesla Model S 100, for example, a total of 8,256 such batteries enable a range of 450 to 500 km.



Electrolyte

The battery cell is filled with an electrolyte. It is made up of a conductive salt and various organic solvents. Any change in the electrolyte formulation affects all of the battery's other components. In addition, a high quality battery has as little water as possible remaining in the electrolyte.

Cathode

The cathode consists of a wafer-thin layer of lithium metal oxide with conductive additives and a binder (a type of adhesive), which is coated onto an aluminum foil. The more uniform and optimized chemical composition and mechanical properties of the electrode, the higher the quality of the battery.

Anode

Graphite is the perfect material for the anode. It is coated onto a copper foil together with binder and usually also with conductive additives, forcing the lithium atoms to find a fixed place in the material's lattice structure. This has the following advantages: higher cycle stability, better performance during rapid charging and higher quality consistency compared to other battery types (such as lead-acid batteries). The purer the graphite, the better this mechanism works. Synthetic graphite handles this task particularly well thanks to its optimized and customizable properties. SGL Carbon's many years of experience in production ensure the consistent quality of the graphite.

Separator

The cathode and anode are separated from one another by a separator, which prevents a short circuit. Yet is must also be as permeable as possible so that the tiny lithium ions can migrate between the anode and cathode when charging and discharging. The separator is usually made of a synthetic compound.