Heraeus

Case Study

POROCARB® IMPROVES THE HEAT DISSIPATION OF YOUR CELL ENABLING LONGER USAGE TIME

Challenge

High-power battery applications face the challenge of low energy output and unsatisfying thermal behavior, e.g. due to temperature cut-off at high power. The performance carbon additive Porocarb® can solve this challenge by enhancing locally the ionic conductivity and improving the thermal behavior of the electrode.

Carbon Performance Additive

Porocarb® is the new design factor for battery systems. The synthetic hard carbon is a macroporous performance additive, optimized for Li-ion batteries (Fig. 1). The Porocarb® grade families are tailored to your specific cell design (cathode and anode) with customized properties such as particle size, pore size, pore volume, specific surface area, electric and thermal conductivity.

Porocarb® offers an open, interconnected macroporous network, which is accessible for the electrolyte, allowing ion transportation throughout its carbon volume. At the same time the carbon backbone has a good thermal conductivity while being mechanical stable. As such, Porocarb® focuses on providing ionic and thermal conductivity vs. common carbon additives rely only on electrical conductivity. Porocarb® itself has double the thermal conductivity of a typical carbon black at the material level (Fig. 2).

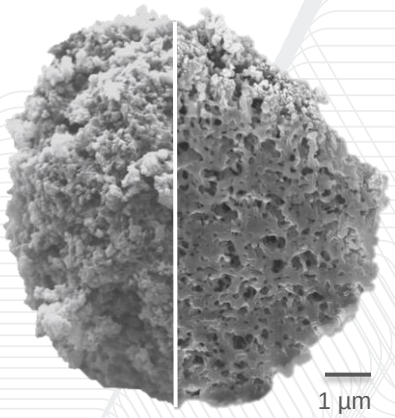

Fig. 1 Single Porocarb® particle with nanoscopic surface area (SEM image; left side) and intrinsic macroporosity (FIB-Cut image; right side).

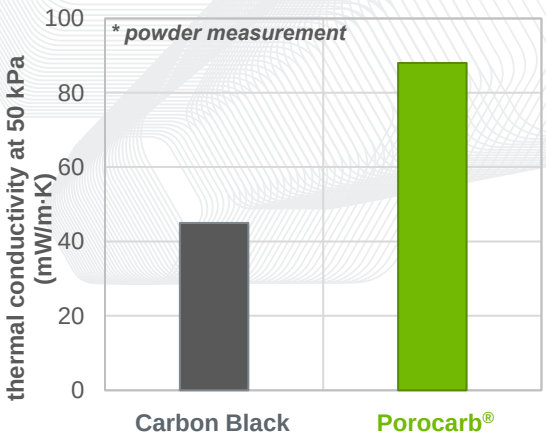

Fig. 2 Thermal conductivity measured at 50 kPa with Transient Plane Source method (ISO 22007-2).

Porocarb®

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Approach

In the following sections, we present one use case for a high power application comparing Porocarb® used in a mixture with carbon black (green) to a reference with carbon black only (grey) with the same total carbon content.

Results

The 1 kHz impedance (Fig. 3A) as well as the discharge performance at 30 A constant current exhibit similar performance (Fig. 3B). The difference of the Porocarb® design is visible in the cell heating during discharge. While even the best reference cell almost hits the 80 °C cut-off temperature, the best Porocarb® cell barely reaches more than 60 °C (Fig. 3C). Considering the difference in cell temperature, another benefit of Porocarb® becomes visible, as Porocarb® provides similar discharge performance even with a colder cell.

The open macroporous network of Porocarb® improves the heat dissipation of the electrode. This enhances the transfer of heat generated at the active material to the electrolyte. As a result, the final cell temperature after discharge is reduced. Since Porocarb® keeps the cell temperature to a minimum, it ensures deeper discharge / longer usage times of the device while improving the cycle life of the battery.

This temperature effect is also beneficial for other battery applications which experience challenging cell heating during fast charging and peak power.

Cathode design in 21700 cell

Reference	4.0 wt.% CB
Porocarb®	1 wt.% **Porocarb®** + 3.0 wt.% CB
Loading	170 g/m²
Density	3.4 g/cm³

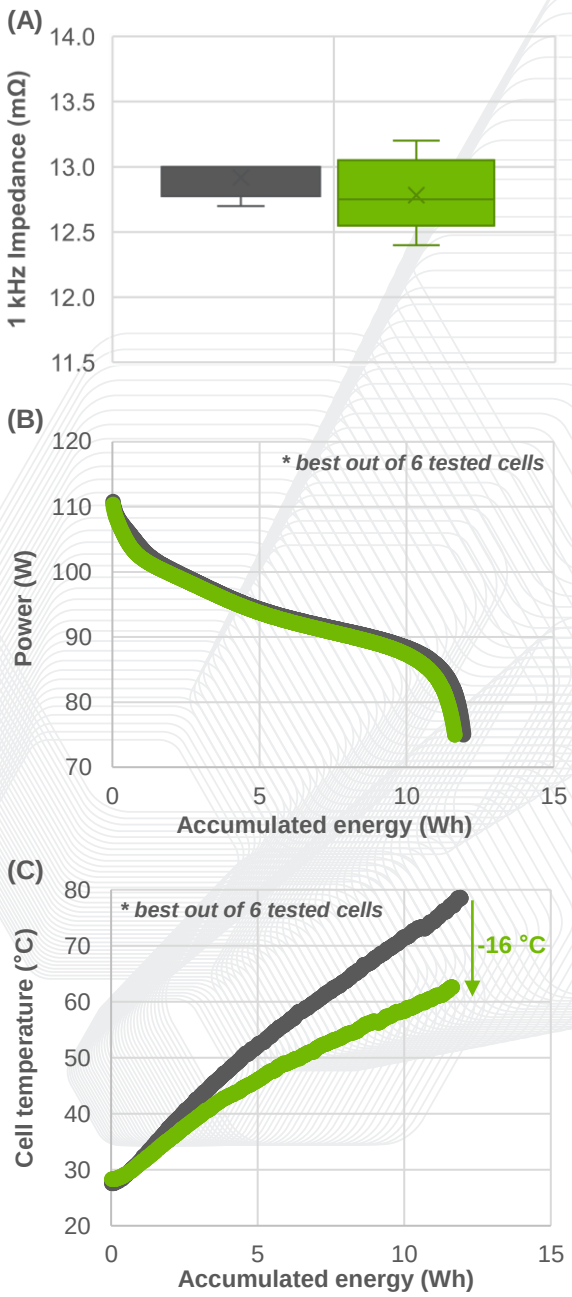

Fig. 3 (A) 1 kHz impedance **(B)** discharge performance at 30 A constant current and **(C)** cell temperature of cells with Carbon Black (grey) and Carbon Black mixed with Porocarb® (green).

Porocarb® L

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