



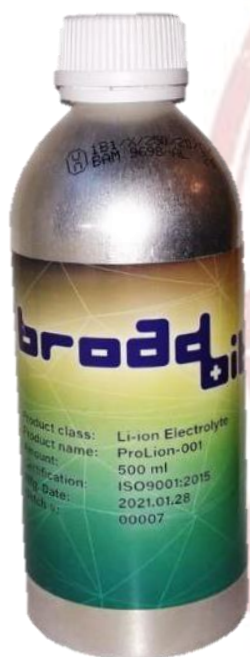
ProLion Electrolyte

Advanced Li-Ion electrolyte enabling world record Li-Ion battery performance

Product Overview

The proper choice of battery electrolyte is key to achieving safe and robust operation, fast-charging, long cycle life and operability in both hot and cold environments.

With BroadBit's ProLion electrolytes, Li-ion batteries set **new world record cycle life** in three important product categories:



- ◆ Highest-Performing LCO batteries
- ◆ Cost-effective LFP batteries
- ◆ Co & Ni-free 4.2 V LMFP batteries

And enables:

- ◆ Extended cycle-life NMC batteries

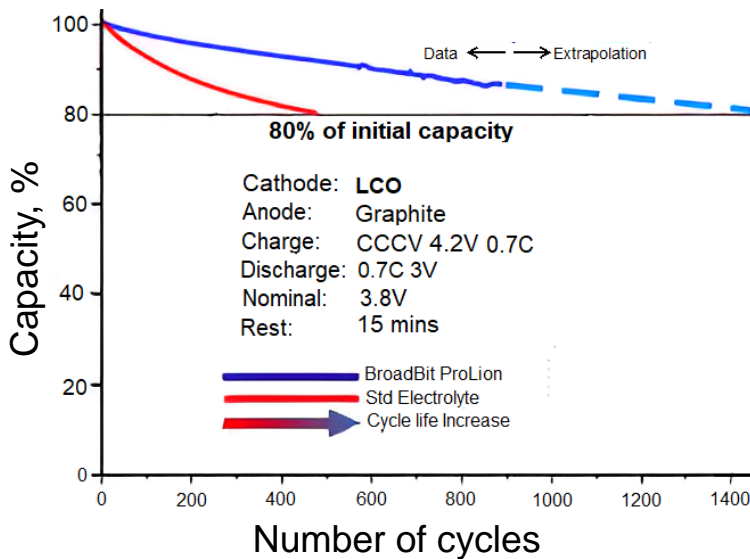
The following pages introduce each of these products. All tests were performed on industrial-format battery cells (18650 cylindrical).

In each product category, the record breaking cycle life implies the lowest levelized battery cost available today (€/kWh/cycle).



Best-Performing LCO batteries achieve record-breaking cycle-life

The rapidly growing EV market demands ever better-performing batteries. LCO and NCM are the two leading performance Li-ion battery technologies.



LCO has several performance advantages over NCM (higher volumetric density, better low-temperature performance, faster charging), but its cycle life was inferior.

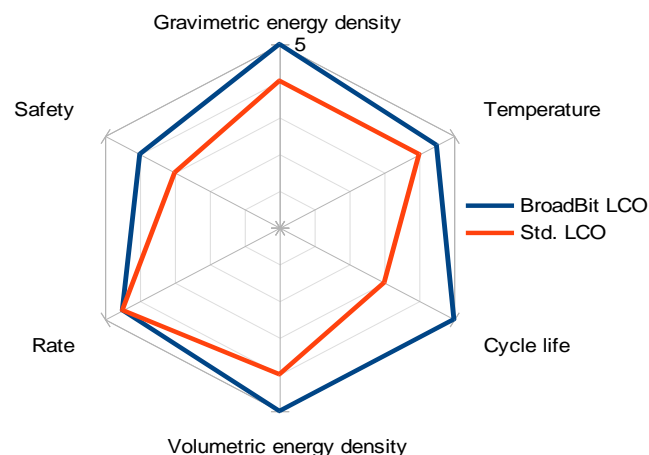
BroadBit's ProLion electrolytes endow LCO batteries with record-breaking cycle life, with 90% of initial capacity retained after 600 cycles. BroadBit estimates that 80% of initial capacity is retained after even 1500 cycles.

Further advantages:

- Increased energy density (> 20% increase in Wh/kg)

LCO cathodes can achieve over 4.1 g/cm³ density with 92% active material content, and with current electrolytes on the market their reversible capacity is 138 mAh/g with respect to the cathode material mass. With our ProLion electrolyte, the same cathode structure can achieve 167 mAh/g stable capacity. This corresponds to 643 Wh/kg gravimetric and 2636 Wh/L volumetric energy density of the cathode structure.

- Improved electrolyte safety (No thermal runaway to 250°C)
- Higher temperature stability (Long term stable to 60°C)

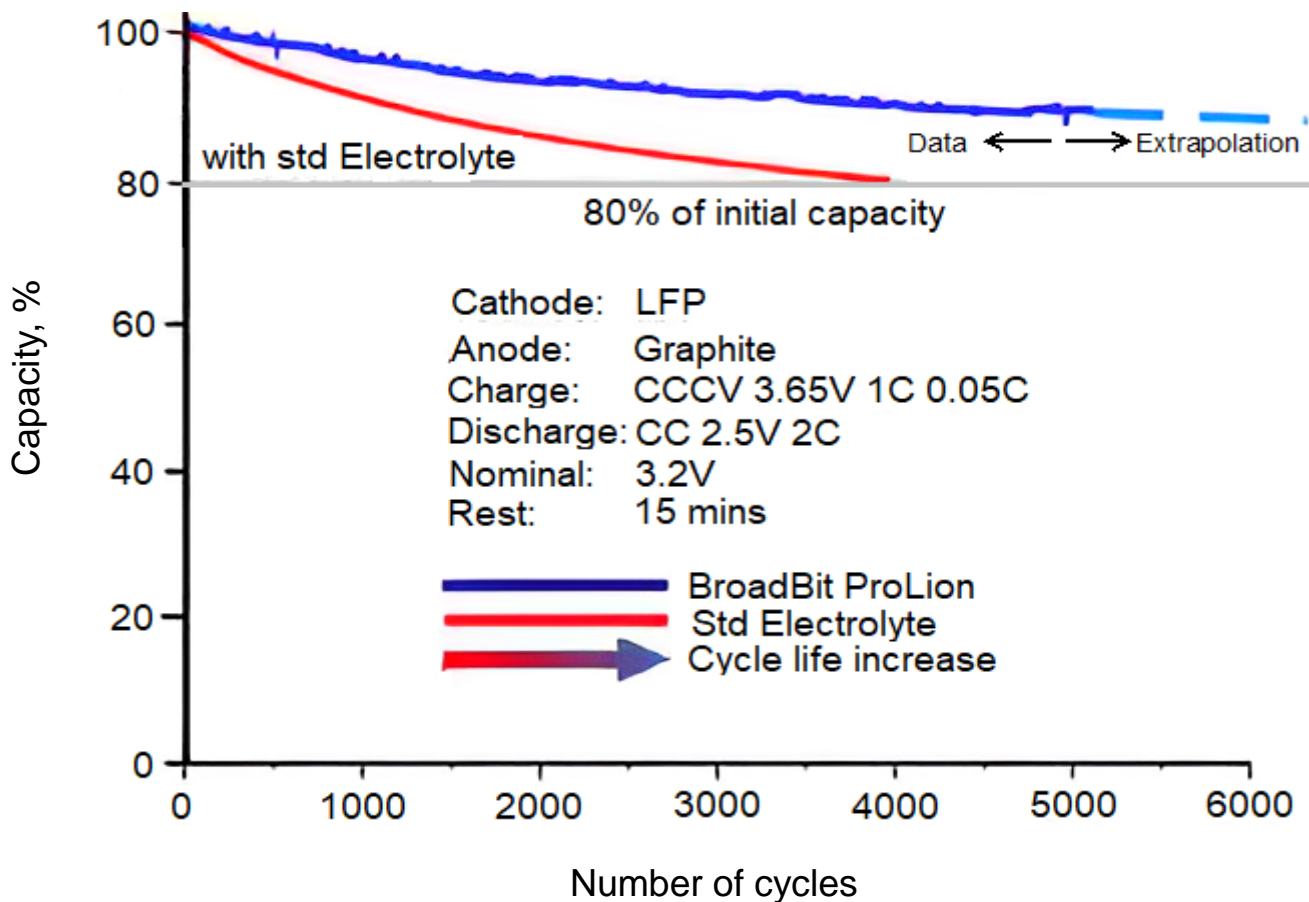




Cost-effective LFP batteries with record-breaking cycle-life

Although LFP batteries have lower energy density than NCM and LCO, several EV manufacturers have recently turned to LFP batteries due to their relatively low cost, massive scalability (due to being cobalt and nickel free) and long cycle life. LFP batteries are advantageous especially for those EVs where battery robustness and sustainability are the most important metrics.

BroadBit's ProLion electrolytes endow LFP batteries with record-breaking cycle life, with 90% of initial capacity retained after 5000 cycles. BroadBit estimates that 80% of initial capacity is retained after even 13000 cycles.



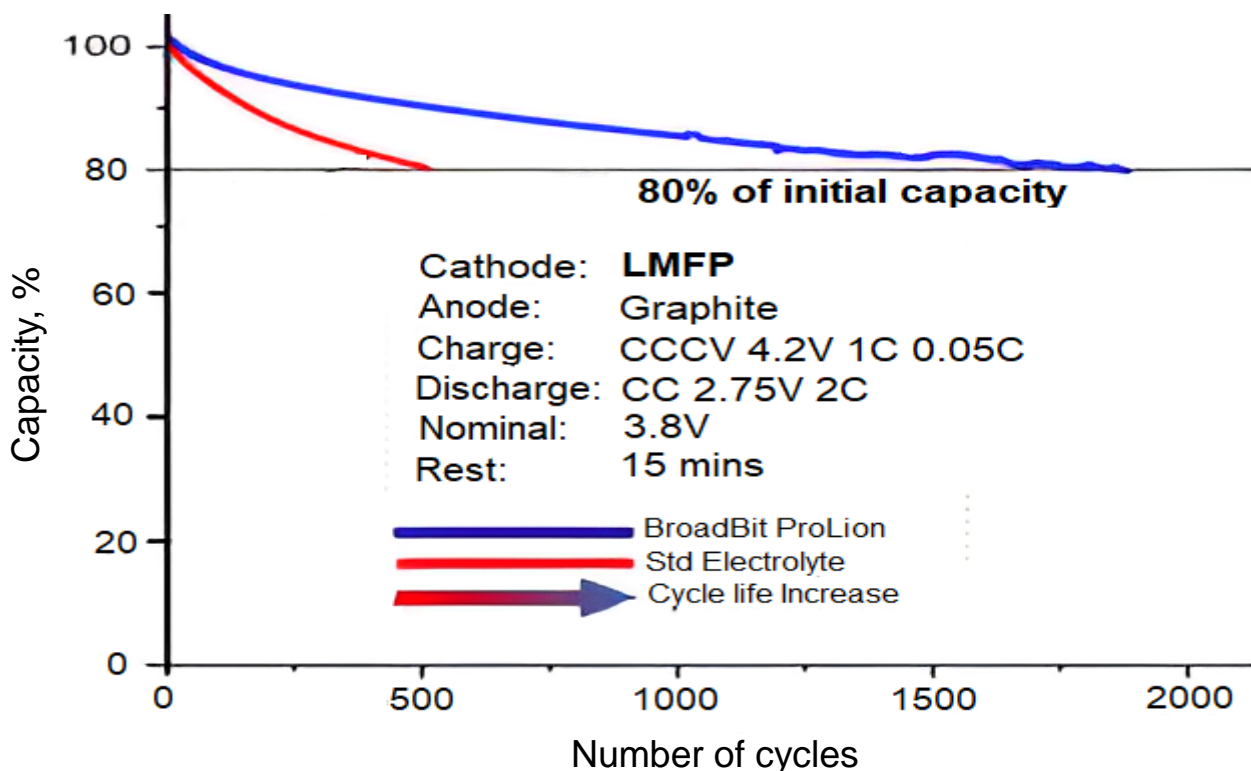
With BroadBit's ProLion electrolytes, EV manufacturers can produce electric vehicles in large volume and with world-leading battery longevity.



Co- and Ni-free 4.2 V LMFP cells with record-breaking cycle-life

4.2 V battery charging systems are the most widely deployed chargers today. There is a growing interest to use cobalt- and nickel-free batteries, such as LMFP, with these existing charging systems because they don't use expensive materials and have higher nominal voltage. However, competitor LMFP prototypes have had too short cycle life for commercial use up to now.

With BroadBit's ProLion electrolytes and LMFP cathodes, our cobalt-, nickel-, and vanadium-free LMFP cells are stabilized for standard 4.2 V chargers, enabling the use of the existing cell charging infrastructure and making LMFP batteries practical for immediate commercial deployment. Based on measured capacity evolution, BroadBit can project with high certainty that 80% of the battery's initial capacity shall be retained after even 1900 cycles even for in-house produced 18650 cells. Serially produced cell should have even better performance.



There are no commercial competitors yet in this product category.

Contact us to learn more about this innovative battery chemistry.

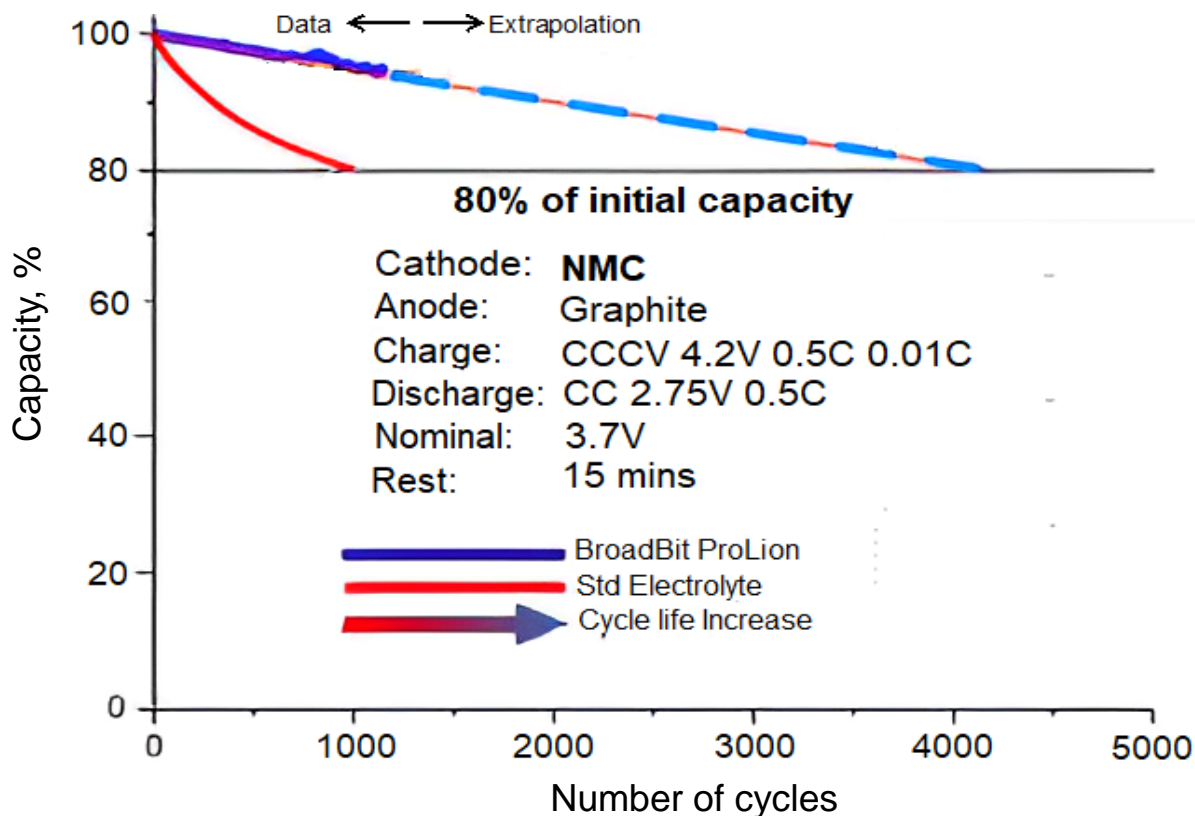


NMC batteries with greatly extended cycle-life

NMC battery is the most popular Li-ion product today. The proper choice of battery electrolyte is key to achieving high NMC longevity. As the following customer case study shows, BroadBit's ProLion electrolytes make a tremendous difference in cycle life.

This customer is a medium-size producer of 2.5 Ah NMC batteries. With traditional electrolyte, their batteries retain 80% of initial capacity after 400 cycles. With BroadBit's ProLion electrolyte, the otherwise identical 2.5 Ah battery retains 95% of initial capacity after 1000 cycles, and is projected to retain 80% of initial capacity after 4000 cycles.

This allowed the customer's NMC battery to achieve market-leading longevity, previously achieved only by few high-end suppliers.



With BroadBit's ProLion electrolytes, NMC batteries achieve their longest possible cycle life.



General Performance Details

In addition to specific chemistry specific performance enhancements, Pro-Lion offers the following general performance benefits over traditional electrolytes:

- Plug-and-place replacement for traditional LiPF_6 -based electrolyte.
- Higher temperature stability (Long term stable up to 75 °C)
- Higher initial cycle Coulombic efficiency (94% for graphite, 91% for NMC)
- Higher low temperature conductivity (3.2 mS/cm at -10 °C)
- Better low-temp. performance (-20 °C capacity retention = 77% of RT)
- Higher voltage / faster charging (Stable up to >4.4 V charging voltage)
- Lower resistance electrode-electrolyte interface / higher discharge capacity (>200 mAh/g @ 0.1C, >180 mAh/g @ 1C)
- Improved safety (No thermal runaway up to 250°C or HF formation w/ H_2O)
- Improved battery cycle-life (Tested for NMC, LCO, LFP & LMFP)

About BroadBit Batteries Oy

BroadBit is a technology company based in Finland revolutionizing the battery industry by developing and commercializing innovative new chemistries and processes to power the future green economy. BroadBit has an extensive patent portfolio covering both Na-salt & Li-ion based battery technologies and unique green manufacturing methods recognized by numerous industry awards.

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