Thin battery with Bending flexibility
About ProLogium

Milestone

Founding

Manufacturing

Technology

Target market
ProLogium™ Technology (PLG) is a next generational Lithium battery cell maker who invented the worldwide first ultra-thin, bendable, high capacity Li-ion battery that never leak, fire, or explode.

With its high technology content and know-how, PLG has been creating this new battery system independently from establishing on Oct 3rd, 2006. Later in 2012 Battery Japan, our first product, FLCB, was released and then mass produced and supplied to worldwide market in 2013.
ProLogium Milestone

**Capital**
- Re-registered in Cayman
- Fundraising A Run
  Leader VC: SBCVC
  (total scale 10MUSD)
- Fundraising B Run
  Leader VC: SBCVC
  (total scale 26MUSD)
- Fundraising C Run
  Leader VC: SBCVC
  (total scale 60MUSD)

**Manufacturing**
- Established SBS Mass Production Line
  • Capacity 37KWh/M
- Established Worldwide First RTR Production Line
  • Capacity 4MWh/M

**Product Line**
- FLCB (FPC package substrate) launched
- PLCB (Al package foil) launched
- ELCB (Li-Metal) tech. announced.

**Tech. (Chemical)**
- AH (RT 1C rate: 50%)
- AP-01 (1C Rate 80%)
- AP-02 (1C RT Rate 92%)
- AP-04 (1C RT Rate ≥96%)
- AP-05 (3C-5C)
- AN-01 (525Wh/L)
Target Market & Entry Point

**Consumer**

- **2017**: Medical / Industry / Military
  - Safety needed
  - Extreme H/L temp.
  - Extreme H/L pressure

- **2018**: BEV
  - Safety needed
  - High E.D (500Wh/L↑)

- **2019**: Smartphone Battery
  - 3C Device: Smartphone

**Niche Market**

- **2017**: Medical / Industry / Military
- **2018**: BEV
- **2019**: Smartphone Battery

Unfair Advantages of PLG

- High E.D (800Wh/L↑)

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Next Generation Battery Solution - LCB (Lithium Ceramic Battery)

- Ultra-Safe
- High Energy Density/Fast Charging
- Fast Charging
- Good H/L Temp. Stability
- Good H/L pressure tolerance
- Ultra-Thin & Flexible

<table>
<thead>
<tr>
<th>Al Foil (Current Collector)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cathode</td>
</tr>
<tr>
<td>Solid state Lithium Ceramic ELT</td>
</tr>
<tr>
<td>No Hard Shorting</td>
</tr>
<tr>
<td>No Thermal Runaway</td>
</tr>
<tr>
<td>No Leakage</td>
</tr>
<tr>
<td>Anode</td>
</tr>
<tr>
<td>Cu Foil (Current Collector)</td>
</tr>
</tbody>
</table>
LCB Features

1. Ultra-Safe
2. High Energy Density
3. Fast Charging Capability
4. Good H/L Temp. Stability
5. Good H/L pressure Tolerance
6. Ultra-Thin & Flexible

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1 features

Ultra-Safe

(Hazard level 2~3)

1. **Physical Impact**: Nail Penetration 3mm & 8mm/secs
2. **Electrical Damage**: Over charge (3C, 12V) / Hard shorting (<=5 mΩ)
3. **Thermal Impact**: Oven Testing (150~200°C)

* Li-Polymer Battery could not pass above safety testing, especially in BEV application 600Wh/L & 250Wh/kg, Total Capacity >=10Ah
Solid-state LCB is the core technology of ProLogium and based on this, we can create various different products with different materials. LCB adopts solid-state electrolyte, so there is NO fire and NO explosion even it’s damaged, folded, punched, penetrated, or abnormal charged. Certainly, NO leakage, either. The following Physical Impact Tests use bare cells without any protecting IC or rigid frames. Experiments confirmed that LCB is intrinsically safe and still dischargeable even after folding, hitting, penetrating, cutting, or burning.
## Ultra-Safe Features

### Lithium POLYMER Battery
- Liquid/Gel Electrolyte
- Al Foil (Current Collector)
- Cathode
- **Polymer Separator**
- Thermal Runaway
- Leakage
- Anode
- Cu Foil (Current Collector)

- Low Melt Point of PE/PP Separator (120~150°C)
- Poor Thermal Stability (85°C, 8hrs ≤10% swelling)
- Poor Low Temp Storage (OK @ -20°C)

### Lithium CERAMIC Battery
- Solid state Lithium Ceramic ELT
- Al Foil (Current Collector)
- Cathode
- **Solid state Lithium Ceramic ELT**
- No Hard Shorting
- No Thermal Runaway
- No Leakage
- Anode
- Cu Foil (Current Collector)

- Hard to be melt of Lithium Ceramic ELT (>1000°C)
- Good Thermal Stability (85°C, 7days ≤10% swelling)
- Good Low Temp Storage (No Problem @ -65°C)
1st Level Derivative Value
High ENERGY

2nd Level Derivative Value
low COST

Core Value
High SAFETY

No problem for Physical Impact
No Problem for Thermal Impact
No Problem for Electrical Damage

=> Adopt the High Utilization Active Material, even with High Safety Risk to increasing the E.D. by Cell level

=> Simplify the Battery Pack design, including BMS, Cooling system and protection material to Increasing the E.D. by Battery Pack level

features
Ultra-Safe
1 features **Ultra-Safe**

### EUCAR (overcharge, penetrate, thermal test)

<table>
<thead>
<tr>
<th>Level</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Passive protection activated (No defect)</td>
<td>Defect (Cell irreversibly damaged)</td>
<td>Leakage ($\Delta$ mass &lt;50%)</td>
<td>venting ($\Delta$ mass ≥50%)</td>
<td>Fire or Flame (No rupture)</td>
<td>Rupture</td>
<td>Explosion</td>
</tr>
<tr>
<td>Safety (EUCAR Level)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLG (AN-01 system)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Density (Wh/L)</td>
<td>523</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific Energy (Wh/Kg)</td>
<td>205</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>International Top tear</td>
<td>520</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>205</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EUCAR pass :  
Level: **2★~3**

EUCAR pass :  
Level: **4~5★**
1 features **Ultra-Safe**

Cell Performance tested by different Car Maker

<table>
<thead>
<tr>
<th>Item</th>
<th>PLG/PLCB</th>
<th>V Company (European car maker)</th>
<th>D Company (European Car maker)</th>
<th>N Company/ W Company (Chinese EV Car Maker)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nail Test</td>
<td><strong>Hazard Level 2</strong>&lt;br&gt;RT;3mm;3~8mm/sec</td>
<td><strong>Hazard Level 2</strong></td>
<td><strong>Hazard Level 2-3</strong>&lt;br&gt;60°C</td>
<td><strong>Hazard Level 2</strong>&lt;br&gt;5~8mm;25mm/sec.</td>
</tr>
<tr>
<td>Over Charge</td>
<td><strong>Hazard Level 2</strong>&lt;br&gt;3C;12V;24hrs</td>
<td><strong>Hazard Level 3</strong>&lt;br&gt;7C '5V @ 25°C</td>
<td><strong>Hazard Level 2, 5C,10V @ 60°C</strong></td>
<td><strong>Hazard Level 2</strong></td>
</tr>
<tr>
<td>Thermal</td>
<td><strong>Hazard Level 2</strong>&lt;br&gt;5°C/min;130°C*10min</td>
<td><strong>Hazard Level 3-4</strong>&lt;br&gt;25~200°C, SOC100%</td>
<td><strong>Hazard Level 3-4</strong>&lt;br&gt;25~200°C, SOC100%</td>
<td><strong>Hazard Level 2</strong>&lt;br&gt;5°C/min;130°C*30min</td>
</tr>
<tr>
<td>Shorting(&lt; 5 mΩ)</td>
<td><strong>Hazard Level 2</strong></td>
<td><strong>Hazard Level 2</strong></td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

【Cell Safety Performance】

1 feature **Ultra-Safe**
2 features

High Energy Density

Chemical Level

1. Li-ion System: 743Wh/L@2018 and will be raised to 933Wh/L@2020
2. Li-Metal System: Will be raised to 1010Wh/L@2021
   * LPB system has 650~680Wh/L limitation due to security issue

Mechanism Level

1. Simplify the mechanism protection (BMS, cooling system and thermal management system)
2. BiPolar+  
3. Cell = Cell Module
4. Large-foot Print
2 features

High Energy Density

【Chemical Level】- Cell Phone (3C) Application (AC system)

- Energy Density of the LCB with Li ion System will be 743Wh/L in the 2018, 833Wh/L @2019 & 933Wh/L @2020
  (and will be Better than LPB system (650~680Wh/L limitation) around 2019!!!)
- Energy Density of the LCB with Li metal System will be 1010Wh/L @2021

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PLG</td>
<td>340</td>
<td>476</td>
<td>680</td>
<td>743</td>
<td>833</td>
<td>933</td>
<td>1010</td>
</tr>
<tr>
<td>Note 7</td>
<td>590</td>
<td>700</td>
<td>650</td>
<td>680</td>
<td>680</td>
<td>680</td>
<td></td>
</tr>
<tr>
<td>iphone7</td>
<td>620</td>
<td>650</td>
<td>680</td>
<td>680</td>
<td>680</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2 features

High Energy Density

【Mechanism Level】 - Energy Density Comparison between BEV Cell level and Pack Level

<table>
<thead>
<tr>
<th></th>
<th>Specific Energy (Wh/kg)</th>
<th>Energy Density (Wh/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tesla Model S</td>
<td>252 53%</td>
<td>709 30%</td>
</tr>
<tr>
<td>GM Spark</td>
<td>173 50%</td>
<td>332 49%</td>
</tr>
<tr>
<td>BMW i3</td>
<td>122 70%</td>
<td>228 53%</td>
</tr>
<tr>
<td>Nissan Leaf</td>
<td>157 57%</td>
<td>317 23%</td>
</tr>
<tr>
<td>Prologium LCB</td>
<td>205 74%</td>
<td>523 56%</td>
</tr>
<tr>
<td>Prologium LCB Module</td>
<td>205 89%</td>
<td>523 69%</td>
</tr>
</tbody>
</table>
2 features

High Energy Density

【 Mechanism Level 】

Single cell for 7.4V~60V or higher voltage, with Bipolar+ Technology ®.

- Direct-Serial & Parallel Technology inside cell.
- Unique Ceramion Technology® without decomposition concern at high voltage.
- Simplify BMS and protection circuit
  - Increase energy density in module level.
  - Reduce module cost at same power.
2 features

High Energy Density

【Mechanism Level】- Cell = Cell Module Level

- Substrate Making
- Electrode Processes
- Electrode Assembly
- Package with Al foil pouch
- Battery Module (EX: 4S32P = 2220Wh)
- Formation
- Battery Pack

Inlay

Cell = Cell Module

Pack

• Higher E.D
2 features
High Energy Density

【Mechanism Level】 - Large-foot Print

G1 RTR line (now)

- 2017: 1.2Ah/
- 2020: 1.9Ah
- 140*220*0.26mm

G2 RTR line (2019)

- 2019: 5.8Ah/
- 2020: 8.4Ah
- 230*570*0.26mm

- 2019: 25.2Ah/
- 2020: 37.1Ah
- 480*1170*0.26mm

Enlarge Inlay Size
3 features

Fast Charging Capability

1. 2C / 30mins: 80~85% (SOC 100%)
2. 3C~5C / 12mins: 55~65% (SOC 100%)
3 features

Fast Charging Capability

Discharge Rate Capability Comparison

<table>
<thead>
<tr>
<th>Item</th>
<th>PLG PLCB_2017</th>
<th>PLG PLCB_2016</th>
<th>China L Company SPXXXXXXX</th>
<th>Japan P Company UFXXXXXXX</th>
<th>Korea L Company ICPXXXXXXX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharging Rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5C</td>
<td><strong>99.7%</strong></td>
<td>99.1%</td>
<td>97.7%</td>
<td>97.6%</td>
<td>97.5%</td>
</tr>
<tr>
<td>1C</td>
<td><strong>99.1%</strong></td>
<td>97.3%</td>
<td>95.8%</td>
<td>94.4%</td>
<td>94.4%</td>
</tr>
<tr>
<td>1.5C</td>
<td><strong>98.4%</strong></td>
<td>92.6%</td>
<td>-</td>
<td>-</td>
<td>84.2%</td>
</tr>
<tr>
<td>2C</td>
<td><strong>94%</strong></td>
<td>85%</td>
<td>89.4%</td>
<td>88.9%</td>
<td>-</td>
</tr>
</tbody>
</table>
3 features

**Fast Charging Capability**

LCB is not only supported 3C fast charging ability, now LCB also has ability to support 5C fast charging and the heating is lower than body temperature during charging process.

<table>
<thead>
<tr>
<th>Ratio</th>
<th>1C (60mins)</th>
<th>2C (30mins)</th>
<th>3C (20mins)</th>
<th>4C (15mins)</th>
<th>5C (12mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1C (60mins)</td>
<td>93.1%</td>
<td>82.1%</td>
<td>72.2%</td>
<td>65.5%</td>
<td>59.2%</td>
</tr>
<tr>
<td>2C (30mins)</td>
<td>87.5%</td>
<td>81.9%</td>
<td>71.8%</td>
<td>59.0%</td>
<td>49.8%</td>
</tr>
<tr>
<td>3C (20mins)</td>
<td>83.1%</td>
<td>76.9%</td>
<td>67.8%</td>
<td>60.0%</td>
<td>51.2%</td>
</tr>
<tr>
<td>4C (15mins)</td>
<td>72.2%</td>
<td>66.8%</td>
<td>57.8%</td>
<td>49.8%</td>
<td>40.8%</td>
</tr>
<tr>
<td>5C (12mins)</td>
<td>65.5%</td>
<td>60.9%</td>
<td>52.8%</td>
<td>44.8%</td>
<td>35.8%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperature (°C) during Charging</th>
<th>1C (60mins)</th>
<th>2C (30mins)</th>
<th>3C (20mins)</th>
<th>4C (15mins)</th>
<th>5C (12mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1C (60mins)</td>
<td>32</td>
<td>30.2</td>
<td>32.8</td>
<td>33.4</td>
<td>33.8</td>
</tr>
<tr>
<td>2C (30mins)</td>
<td>25.9</td>
<td>30.2</td>
<td>32.8</td>
<td>33.4</td>
<td>33.8</td>
</tr>
<tr>
<td>3C (20mins)</td>
<td>32.8</td>
<td>33.4</td>
<td>33.8</td>
<td>33.8</td>
<td>33.8</td>
</tr>
<tr>
<td>4C (15mins)</td>
<td>33.4</td>
<td>33.4</td>
<td>33.8</td>
<td>33.8</td>
<td>33.8</td>
</tr>
<tr>
<td>5C (12mins)</td>
<td>33.8</td>
<td>33.8</td>
<td>33.8</td>
<td>33.8</td>
<td>33.8</td>
</tr>
</tbody>
</table>
4 features

Good H/L Temp. Stability

1. Operation Window for Charging Process: LCB/65~85°C vs LPB/45°C
2. Operation Window for Discharging Process: LCB/85~95°C vs LPB/60°C
3. Storage Window for High temp: LCB/85°C vs LPB/60°C
4. Storage Window for Low temp: LCB/-65°C vs LPB/-20°C
**4 features Good H/L Temp. Stability**

【 Lithium POLYMER Battery 】
- Liquid/Gel Electrolyte
- Al Foil (Current Collector)
- Cathode
- Polymer Separator
- Thermal Runaway
- Leakage
- Anode
- Cu Foil (Current Collector)

【 Lithium CERAMIC Battery 】
- Al Foil (Current Collector)
- Cathode
- Solid Lithium Ceramic ELT
- No Hard Shorting
- No Thermal Runaway
- No Leakage
- Anode
- Cu Foil (Current Collector)

- Low Melt Point of PE/PP Separator (120~150°C)
- Poor Thermal Stability (85°C, 8hrs <=10% swelling)
- Poor Low Temp Storage (OK @-20°C)

- Hard to be melt of Ceramic ELT (>1000°C)
- Good Thermal Stability (85°C, 14 days <=10% swelling)
- Good Low Temp Storage (No Problem @-65°C)
Good H/L Temp. Stability

<table>
<thead>
<tr>
<th>Reliability Test</th>
<th>Operation Temp.(Charge)</th>
<th>Operation Temp.(Discharge)</th>
<th>Storage Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-20~85°C</td>
<td>-25~90°C (105°C*)</td>
<td>-65°C (3Month)~85°C (14D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>@4.35V or *105°C (14D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-20~60°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Industrial spec)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Car spec)</td>
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<tr>
<td></td>
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<td>(Car spec)</td>
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<td>(Military spec)</td>
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<td>(Car spec)</td>
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<td></td>
<td>(Car spec)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Car spec)</td>
</tr>
</tbody>
</table>

- 4 features
- Good H/L Temp. Stability

- **H/T Charging**: 45°C (~85°C)
- **L/T Discharging**: -20°C (~25°C)
- **H/T Discharging**: 60°C (~90°C)
- **L/T Storage**: -65°C

* Voltage sill limited around 3.8~4.0V@105°C
## Good H/L Temp. Stability

<table>
<thead>
<tr>
<th></th>
<th>RT/0.2C</th>
<th>-25°C/0.2C</th>
<th>-25°C/0.5C</th>
<th>-25°C/0.75C</th>
<th>-25°C/1C</th>
</tr>
</thead>
<tbody>
<tr>
<td>ProLogium</td>
<td>100%</td>
<td>73.5%</td>
<td>43.9%</td>
<td>32.0%</td>
<td>27.2%</td>
</tr>
<tr>
<td>A Company</td>
<td>100%</td>
<td>76.2%</td>
<td>35.1%</td>
<td>2.2%</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

-25°C Discharge Rate Capability

Performance is far ahead of polymer cell at -25°C.

Almost no capacity can be discharged at -25°C.
5 features

Good H/L pressure tolerance

From Underwater to Outer Space

Extremely Low Pressure, Vacuum Level : $10^{-11}$ ATM

High Pressure Tolerance : 48 ATM (Underwater 470M)
5 features
Good H/L Pressure Tolerance

【 Chemical level 】

【 Lithium POLYMER Battery 】
Liquid/Gel Electrolyte
Al Foil (Current Collector)
Cathode
Polymer Separator
Anode
Cu Foil (Current Collector)

[Image showing thermal runaway and leakage]

- Polymer Separator (PE/PP) is easy to be deformed by Outside pressure
- Outside Pressure on LPB => Hard Shorting / Soft Shorting

【 Lithium CERAMIC Battery 】
Al Foil (Current Collector)
Cathode
Solid state Lithium Ceramic ELT
Anode
Cu Foil (Current Collector)

[Image showing no hard shorting, no thermal runaway, and no leakage]

- Ceramic ELT (Oxide) is hard to be deformed by Outside pressure
- Outside Pressure on LCB => Performance go normally
5 features

Good H/L Pressure Tolerance

【 Architectures Level 】

【 Lithium POLYMER Battery 】
- Vacant in outside package and inner layer
- Swelling During Ultra-low Pressure.

【 Lithium CERAMIC Battery 】
- Every layer is chemical bonded together
- No Swelling during Ultra-Low Pressure.

<table>
<thead>
<tr>
<th>Cell</th>
<th>Item</th>
<th>Polymer</th>
<th>ProLogium LCB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>Operation Pressure.(High)</td>
<td>No Positive Pressure</td>
<td>50 Kg/cm²</td>
</tr>
<tr>
<td>Test</td>
<td>Operation Pressure.(Low)</td>
<td>&gt;/= 0.6 atm</td>
<td>10⁻¹¹ atm</td>
</tr>
</tbody>
</table>
Other Features

LCB ACIR Improvement
Long Cycle Life
LCB Long Cycle Life

Low Temp. (LT): 12°C, 500 times, 0.5C/0.5C

High Temp. (HT): 60°C, 1000 times, 0.7C/0.5C

High Vol. (HV): 4.4V, 500 times, 1C/1C

High Vol. (HV+HC): 4.35V, 500 times, 2C/3C

High Vol. (HV+HT): 4.35V, 500 times, 45°C
LCB Product Line

FLCB (FPC type-LCB) / TLCD (Tubular type-LCB)

PLCB (Pouch type-LCB)

ELCB/ Logithium (High Energy Density-LCB)
LCB (Lithium Ceramic Battery)

- No Hard Shorting
- No Leakage
- No Thermal Runaway

**FPC**

- **FLCB -A**
  - Flexible
  - 0.38mm
  - H/L pressure
  - Durability

- **FLCB -B / ELCB**
  - Flexible
  - 1010Wh/L ↑

**Al**

- **PLCB -A**
  - H/L Temp.
  - Durability
  - High E.D
  - Bipolar
  - Adoptable

- **PLCB -B / ELCB**
  - 1010Wh/L ↑

- **Wide Operation Window**
Li-ion with FPC substrate / package materials
Thickness: 0.38 mm
Dynamic Bending
Logical Battery (System on Flex)

Injection Molding Adoptable (120°C, 60 sec)
Great High / Low Pressure Durability
FWI Technology: 10,000 times bending @R15mm
Able to do “tubular” cell, TLCB
FLCB Electrical Performance

Charging/ Discharging/ Operation Temp./ Cycle life
Based on FLCB package type, TLCB is the smallest diameter that passes the test is “4-5mm”.

Provide more flexible design for cylindrical device.

No fire, no explosion after punching, breaking, or soaking in water.
PLCB

Ultra Safe.
Wide Operation Window/ Storage temp.
Higher Theoretical Energy Density Than LPB (no sacrifice for safety)
PLCB Electrical Performance

Charging/ Discharging/ Operation Temp./ Cycle life

![Graphs showing PLCB Discharge Rate, Charge Rate, Operation Temp., and Cycle Life](image)
ELCB (Logithium)

1010Wh/L, 1.2-1.5 times of current LPB Li-Metal anode.
Sample delivery in 2019 H2.
ELCB Electrical Performance

Charging/ Discharging/ Operation Temp./ Cycle life

- ELCB Discharge Rate
- ELCB Charge and Discharge Rate
- ELCB Operation Temp.
- ELCB Cycle Life
Application (by Category)

EV
Industry / Medical
Consumer / Wearable
IOT / Card
Smartphone
Based on the same condition 30 minutes, Tesla’s EV battery is 60% fully charged only, LCB EV brick is 82% fully charged also LCB EV brick endurance is 107 km more.
The temp. during fast charging is lower than human body.
【Cell Level】

- 2nd Tech. → 3rd Tech.
- Si/graphite → Si (100%)

**PLCB Energy Density Roadmap PLCB3260105A/B**

<table>
<thead>
<tr>
<th>Year</th>
<th>Energy Density (Wh/L)</th>
<th>Energy Density (Wh/Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>420</td>
<td>160</td>
</tr>
<tr>
<td>2017</td>
<td>523</td>
<td>205</td>
</tr>
<tr>
<td>2018</td>
<td>643</td>
<td>241</td>
</tr>
<tr>
<td>2019</td>
<td>736</td>
<td>274</td>
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<tr>
<td>2020</td>
<td>832</td>
<td>306</td>
</tr>
<tr>
<td>2021</td>
<td>1073</td>
<td>380</td>
</tr>
</tbody>
</table>

**Graphite/Si System**

- LCB-02.5
- LCB-02.6
- LCB-03.1
- LCB-03.1
- LCB-03.2
- LCB-03.3

**Pure Si**
【Pack Level】

- PLG battery cell is **ultra-safe** → ME (cooling and thermal management) & BMS protection can be less → pack E.D of PLG is higher than others.

<table>
<thead>
<tr>
<th>Year</th>
<th>PLCB</th>
<th>Tesla/ Panasonic (18650)</th>
<th>GM/ LGC (LPB)</th>
<th>BMW i3/ SDI (LIB)</th>
<th>Nissan/ AESC (LPB)</th>
<th>BYD (LFP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>218</td>
<td>211</td>
<td>162</td>
<td>121</td>
<td>73.6</td>
<td>77</td>
</tr>
<tr>
<td>2017</td>
<td>294</td>
<td>222</td>
<td>179</td>
<td>138</td>
<td>88.6</td>
<td>80</td>
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<tr>
<td>2018</td>
<td>341</td>
<td>222</td>
<td>196</td>
<td>156</td>
<td>103.5</td>
<td>84</td>
</tr>
<tr>
<td>2019</td>
<td>390</td>
<td>233</td>
<td>213</td>
<td>173</td>
<td>112.7</td>
<td>89</td>
</tr>
<tr>
<td>2020</td>
<td>441</td>
<td>233</td>
<td>229</td>
<td>191</td>
<td>121.9</td>
<td>93</td>
</tr>
</tbody>
</table>

PLG > All batteries in 2017. PLG > 18650 89% in 2020.
Power Exoskeletons

Balanced weight by dispersing batteries back & front
Ultra Safe, Flexible

Portable Inspection Device
Ultra safe.
High Energy Density.
Wide Temperature Operation Window.

FLCB inside
PLCB inside
Power Vest

Wearable power bank
Ultra-Safe
Flexible: >3000 cycles with R50
Disperse the battery weight averagely.
Hands free.

Power Life Jacket

Foldable, able to be on aircraft.
IPx7 level, good durability of high altitude.
GPS/ Lighting functions.
Rugged Tablet / IOV

Ultra-Safe
High Energy Density compared to NiMH battery
-20 °C~85 °C Charge, -25 °C~90 °C Discharge
Storage 14 days at 105 °C
2C discharge at 105°C for 5 cycles
IIOT Application

Ultra-Safe, Tubular, Ultra-Thin

Wider operation window (105 °C discharge)

Survived at extreme vacuum environment (10^{-11} ATM)
AGV/Bomb Disposal Vehicle/Lift Truck

- Ultra-Safe
- High Energy/ Power Density
- Wide Operation Window

UAV/Drone

- Disperse the battery weight averagely
- Good thermal stability
- Wide Operation Window
- No fire & No smoke even after shooting.
Power Band for Smart Watch

Embedded flexible FLCB inside the band by injection molding as watch main power or extended power.
Smart Helmet

Ultra-safe. No fire and still workable even battery cells are damaged from accident.
Forward-facing dashcam, rear-facing camera, GPS, navigator..., etc.

Flexible Power Bank

Flexible, ultra-thin
So soft that won’t change bag’s shape.
Power Flip / Case

More than enough juice for single day use.
One button charging. No need to take off case.
No Need Power Bank anymore.
Able to integrate wireless charge module.

Power Leaf

Ultra Thin, Flexible
700mAh Capacity for Emergency Use
Smart Clothing

Flexible, Comfortable, Ultra-thin.
Ultra-Safe, No Leakage.
Detecting/Monitoring Body Status.

Smart Insole

Flexible, Pass 400,000 times bending test.
Ultra-safe, Ultra-thin.
Collecting movement data / GPS.
Power Belt

Multiple functions such as charging smartphone, GPS, tracking, detecting..., etc.

Power Backpack

Invisible battery inside the backpack for power bank use, emergency backup power use, or outdoor activity use..., etc.
Temp. Sense Patch

- Rechargeable.
- Ultra-thin. Comfortable.
- Ultra-safe.

RFID sensor / Tracking Tag

- Rechargeable.
- High Temperature Resistance
- Flexible, Ultra-thin (0.38mm).
Finger Print Card
For security check of payment, bank, or entrance guard,...etc. with finger print
Rechargeable
Ultra-thin

Smart Display Card
Keypad/circuit directly on cell
Triple Power
Ultra-thin

Conventional Li-poly.
(10-15mAh)

Multi-Functional Cell.
(30-35mAh)
Functional Display Card

Wireless charging.
Antenna directly on battery cell.
Triple Power.
Modularized.

Conventional Li-poly.
(5-8mAh)

Multiple Functional Cell.
(15-17mAh)

FLCB inside
Multi-Functional Cell

Able to combine Lithium cell on one side of the battery and components like logic circuit, credit card keypad on the other side. Save space. Integrating with original buttons’ area, battery capacity is 300% bigger than that of competitors’.

Bigger Capacity  Keypad on Battery  Ultra-Safe  SOF
Stylus

- FLCB is formed into a small cylinder by rolling.
- Ultra-Safe

Thermometer

- Ultra-safe
- Tubular, ultra-thin
- Discharge at 105°C
IP Map

Total 155 Patents
Issued : 70
Filed : 85

Core Tech : LCB (Lithium Ceramic Battery)
Issued : 70
Filed : 85

Ceramion Tech. (Lithium Ceramic Electrolyte)

BOF Tech. (Battery on FPC Substrate)

Logithium Tech (Lithium-Metal System)

Sealicone Tech. (Package Mechanism)

Specific Equipment

Application : Cover Battery, Watchband Battery
Awards

Certifications
## Standard Product Spec

<table>
<thead>
<tr>
<th>Product</th>
<th>FLCBxxxxxxxAAAA</th>
<th>PLCB</th>
<th>TLCB</th>
<th>Width (mm)</th>
<th>Nominal Voltage (V)</th>
<th>Max Voltage (V)</th>
<th>Nominal Capacity (mAh)</th>
<th>Thickness (mm)</th>
<th>D0/D1 (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>027038</strong></td>
<td>27*38</td>
<td>52*55</td>
<td>47D3L8</td>
<td>29</td>
<td>3.75</td>
<td>4.35</td>
<td>17</td>
<td>0.43</td>
<td>2.5/5.5</td>
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<tr>
<td><strong>046046</strong></td>
<td>46*46</td>
<td>60*105</td>
<td>47D3L8</td>
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<td>3.75</td>
<td>4.35</td>
<td>45</td>
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<td><strong>051076</strong></td>
<td>51*76</td>
<td>133*218</td>
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<td>3.8</td>
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<td>100</td>
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<td><strong>107163</strong></td>
<td>107*163</td>
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<td>3.8</td>
<td>4.4</td>
<td>515</td>
<td>0.43</td>
<td></td>
</tr>
</tbody>
</table>

**w/o terminal**

*Contents as above is for reference only. Please contact with our salesperson for full spec based on specific product.*