Thin battery with bending flexibility
• Founded in 2006
• 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)
• Established First Mass Production Line (SBS Production Line) Capacity 37KWh/M
• Established Worldwide Leadership Production Line (RTR Production line) Capacity 4MWh/M
• Portable device market: hTC Power Flip Case
• Wearable electronics Market: Power & GPS Belt
• IOT (Smart Card) Market
• Industrial application Market

2017
• LCB_AN-01 E.D 555Wh/L 85°C Discharge Cycle Life 1000times ACIR 20mΩ

2014
• LCB_AP-01 (1C Rate 80%)

2012
• LCB_AH (RT 1C rate: 50%)

2015
• LCB_AP-02 (1C RT Rate 92%)

2006
• FLCB (Flexible/FPC package substrate) product announced.
• ELCB (Li-Metal) tech. announced.
• PLCB (Al package foil) product launched.
• LCB_AP-04 (1C RT Rate ≥96%)
Product & Application

LCB (Lithium Ceramic Battery)

FLCB (FPC type-LCB)

PLCB (Pouch type-LCB)

ELCB/ Logithium (High Energy Density-LCB)
PLG Next Generation Battery Solution - LCB (Lithium Ceramic Battery)

- Ultra-Safe
- Ultra-Thin
- Flexible
- High Energy Density
- Good H/L Temp. Stability
- System on Flex

<table>
<thead>
<tr>
<th></th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al Foil (Current Collector)</td>
<td></td>
</tr>
<tr>
<td>Cathode</td>
<td></td>
</tr>
<tr>
<td>(Solid-State) Ceramic Electrolyte</td>
<td>No Hard Shorting</td>
</tr>
<tr>
<td>Anode</td>
<td></td>
</tr>
<tr>
<td>Cu Foil (Current Collector)</td>
<td></td>
</tr>
</tbody>
</table>

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## Ultra-High Safety

### Lithium CERAMIC Battery

- Hard to be melt of S-Ceramion (>1000°C)
- Good Thermal Stability (85°C, 7 days ≤10% swelling)
- Good Low Temp Storage (No Problem @-65°C)

### Lithium POLYMER Battery

- 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)
Energy Density (Wh/L) - Smartphone

- Li-Polymer battery seeks for high E.D but sacrifices safety and explodes easily.
- LCB theoretical energy density is higher than LPB and also keeps great safety.
Cell level comparison

PLG Li-Metal E.D > 18650 in 2018

Dangerous Zone

PLG Li-ion E.D > LPB NOW

source: ITRI 2015/6/9   * Grow 5% every years. Resource from: Digitimes 2015/7/29
Pack level comparison

- 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.

PLG Li-ion E.D > all battery NOW.

source: ITRI 2015/6/9, Digitimes 2015/7/29*
# Wide Operation Window

<table>
<thead>
<tr>
<th>Battery cell</th>
<th>Item</th>
<th>ProLogium LCB</th>
<th>Li Polymer Battery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Operation Window (Charging)</td>
<td>-20~65°C</td>
<td>0-45°C</td>
</tr>
<tr>
<td>Reliability</td>
<td>Operation Window (Discharging)</td>
<td>-30~85°C</td>
<td>-20~60°C</td>
</tr>
<tr>
<td></td>
<td>Storage Temp.</td>
<td>-65~60°C</td>
<td>-10~45°C</td>
</tr>
</tbody>
</table>

## Operation Window

<table>
<thead>
<tr>
<th>Low temp Storage</th>
<th>High temp Storage</th>
<th>High Temp Charging</th>
<th>High Temp Discharging</th>
</tr>
</thead>
<tbody>
<tr>
<td>polymer</td>
<td>-20</td>
<td>60</td>
<td>45</td>
</tr>
<tr>
<td>ProLogium LCB</td>
<td>-65</td>
<td>60</td>
<td>65</td>
</tr>
</tbody>
</table>
• PLG Standard CH/DCH & Rate Capability is close to Li-Polymer batteries (liquid/jelly type).
LCB Cycle Life & Operating Temp.

- PLG Cycle Life & Operating Temp. is close to Li-Polymer batteries (liquid/jelly type).
LCB vs. LPB

- LCB performance has been greatly improved in all aspects, especially safety, operating temperature, thickness and bending ability is better than Li-Polymer battery.
- ELCB energy density will significantly exceed the Li-Polymer battery. (2018)
LCB (Lithium Ceramic Battery)

- No Hard Shorting
- No Leakage
- No Thermal Runaway

**FPC package**
- **FLCB - A**
  - Flexible
  - 0.38mm
- **FLCB - B / ELCB**
  - Flexible
  - 810Wh/L
- System on Flex

**AI package**
- **PLCB - A**
  - >/= 1 mm.
  - Lower Cost Version
  - Unlimited E.D
- **PLCB - B / ELCB**
  - Inflexible
  - 810Wh/L
- Wide Operation Window
FLCB

Revolutionary Battery
Dynamic Bending (TLCB)
Logical Battery (System on Flex)
Ultra thin, Ultra safe (0.38mm)
A FLCB cell in use keeps working even cut into pieces and stabbed with a pair of scissors. The battery used in following Physical Impact Tests are all bare cells without any protection IC or rigid frame’s security. Experiments confirmed that FLCB is intrinsically safe and still dischargeable even after folding, hitting, penetrating, cutting, or burning.
FLCB Target Market

Dynamic Bending

Wearable
- Smart Watch/Smart Cloth/Belt/Insoles/VR/Helmet....
- Temp. Sense Patch....

System On Flex

IOT(Cards)
- BLE bank/credit card.
- Active RFID/Smart Display Card/Functional Card/OTP card/All-in-One Card,
- Logistic sensor/Recorder

Able to be Rolled

Tubular Cell
- Electrical Cigarettes
  - Stylus
- Bluetooth Headset

Durable at High Temp.

Able to be Injection Molded
- Silicon compression molding (<120°C, 1min)
- TPU/TPR injection molding (>180°C, 3-5 sec)
Power Band for Smart Watch

- Extended 50~100% power.
- Flexible, bendable, twistable.
- Cell & belt 2 in 1. Battery cell is able to be injection molded inside the band.
- Ultra-Safe. Able to be injection molded under 200-260°C in 3-5 sec.
Power Band for Smart Watch

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

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

Individual-Soldier System

- Disperse the battery weight back & front.
- Ultra-safe. No fire & No smoke even after shooting test.
Power Belt

- Functions like charging, sensor detecting...etc. are all possible.
- Looks and works like general belt.
- No fire, no explosion after punching, penetrating, or cutting.
- Comfortable to wear.

Unlimited Functions  Ultra-Safe  Flexible  Soft Package
Power Belt

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

AR/VR

- Ultra-thin and flexible
- Electricity cable is no longer needed with head set.
- LCB parallel with original battery of head set to increase capacity and usage time.
Temp. Sense Patch

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

RFID sensor / Tracking Tag

- Rechargeable.
- High Temperature Resistance
- Flexible, Ultra-thin (0.38mm).
Smartphone Wallet with Power Bank

- Wallet, phone case and power bank 3 in 1.
- Charging anytime, anywhere.

Flexible Power Bank

- Flexible, ultra-thin
- So soft that won’t change bag’s shape.
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’.
Smart Display Card

- Keypad/circuit directly on cell.
- Triple Power.
- Ultra-thin.

Conventional Li-poly.
(10-15mAh)

Multi-Functional Cell.
(30-35mAh)
Antenna Cell

- Antenna Cell is the worldwide first and only Li-battery that can integrate antenna directly on cell.
- Increases card battery capacity by 300%.
- Ultra-thin module (<0.45mm).
Functional Display Card

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

Conventional Li-poly. (5-8mAh)

Multiple Functional Cell. (15-17mAh)

PLG inside
• 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.
e-cigarette

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

Stylus

- FLCB is formed into a small cylinder by rolling.
Bluetooth Headset

- Ultra-Safe
- Low-Priced. Compared to international tier cell maker, TLCB price can be 20%-50% lower.

Power Juice Pack

- Ultra-Safe, no need any extra mechanical protection for battery.
- Cell is able to be compression molding inside the silicon.
PLCB

Ultra Safe.
Wide Operation Window/ Storage temp.
Higher Theoretical Energy Density Than LPB (no sacrifice for safety)
Based on Solid-state and incombustible LCB technology, PLCB is extremely safe. No matter how to abuse it or torture it, PLCB still no smoke, no fire, and no explosion. Furthermore, its electrical performance at High temp and Low temp during discharging and storage is especially suitable for industrial application and in frigid zone, desert, or the critical environments that crash / penetrate often.
PLCB Target Market

**Consumer Application**
- Smartphone accessories:
  - Power case, Power jacket, Power Flip Case, Power bank
  - ebook, Tablet

**EV Application**
- EV
  - Large foot-print application
  - Large capacity application
  - High/Low Temp. application

**Medical/Industrial**
- Ultra-Safe
  - Large foot-print application
  - Large capacity application
  - High/Low Temp. application
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.

Times between charge for heavy user is 36hrs.
BEV

• Extremely High Safety. EUCAR Hazard Level 2-3.
• High Volume Utilization. Save cost by simplify the cooling system, thermal management system, and BMS.
• High Energy Density.

Battery Pack composition

- 70%-50% pack
- 30%-50% cell

- EUCAR Hazard Level: 2~3
- 538Wh/L, 206Wh/Kg (2017/E)
Electric Stacker/ Lift Truck
- Ultra-Safe
- High Energy Density
- Good Thermal Stability
- Long Cycle Life

Rugged Tablet/ Portable Inspection Device
- Ultra-Safe
- High Energy Density
- Good Thermal Stability
- Long Cycle Life
Power Vest

- Ultra-Safe: for personal/baby
- Flexible: >3000 cycles with R50
- Wide Operation Window

Power Exoskeletons

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

- Ultra-Safe
- High Energy/ Power Density
- Wide Operation Window
- Long Cycle Life

UGV

- Disperse the battery weight averagely
- Good thermal stability
- Wide Operation Window
- No fire & No smoke even after shooting.
ELCB (Logithium)

810Wh/L, 1.2-1.5 times of current LPB
Li-Metal anode.
Sample delivery in 2018 H2.
# New Li-Metal vs. Original Li-ion

<table>
<thead>
<tr>
<th>(single cell)</th>
<th>Li-Metal (ELCB)</th>
<th>Li-ion (FLCB/PLCB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al Foil thickness</td>
<td>15um</td>
<td>25um</td>
</tr>
<tr>
<td>Cathode thickness</td>
<td>93um</td>
<td>93um</td>
</tr>
<tr>
<td>Ceramic ELT thickness</td>
<td>40um</td>
<td>~35um</td>
</tr>
<tr>
<td>Anode thickness</td>
<td>EIC + AIMC: 30um</td>
<td>~105um</td>
</tr>
<tr>
<td>Copper Foil thickness</td>
<td></td>
<td>18um</td>
</tr>
<tr>
<td>Total Thickness</td>
<td>0.178mm</td>
<td>0.276mm</td>
</tr>
</tbody>
</table>
ELCB Roadmap

810Wh/L@2018, 1.2-1.5 times of current LPB

- **2018**: 810Wh/L
- **2019**: 935Wh/L
- **2020**: 1002Wh/L
ELCB Sample Delivery Schedule

**System: BC-01**
Model: PLCB4360105B
Sample Making Mode: SBS line
QTY: 60 sets

**System: BC-01**
Model: PLCB4360105B
Sample Making Mode: RTR line
QTY: 100 sets

**System: BC-02**
Model: PLCB4360105B
Sample Making Mode: SBS line
QTY: 30 sets

---

2018/Dec
(BC-01/SBS)

Performance:
- Energy density = 810Wh/L
- 1C Rate >/= 88%
- 0.5C Cycle* 500th > 80%

2019/6
(BC-01/RTR)

Performance:
- Energy density = 810Wh/L
- 1C Rate >/= 90%
- 0.5C Cycle* 500th > 80%

2019/6
(BC-02 1st Sample)

Performance:
- Energy density = 900Wh/L
- 1C Rate >/= 85%
- 0.5C Cycle* 300th > 80%

2019/Sept
(MP)
IP Map

80 Issued Patents, 30 Filed Patents

Ceramion Tech.
(lithium ceramic electrolyte)

BOF Tech.
(battery on FPC substrate)

Logithium Tech
(Lithium-Metal system)

Sealicone Tech.
(package mechanism)

Application Cover Battery, Band Battery

Core Tech : LCB
(Lithium Ceramic Battery)

Issued: 80
Filed: 30

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Awards

Certifications
# Standard Product Spec

<table>
<thead>
<tr>
<th>Product</th>
<th>FLCB</th>
<th>PLCB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>027038</td>
<td>051076</td>
</tr>
<tr>
<td>Dimension (mm)</td>
<td>27*38</td>
<td>46*46</td>
</tr>
<tr>
<td>*w/o terminal</td>
<td>27*38</td>
<td>46*46</td>
</tr>
<tr>
<td>Nominal Voltage (V)</td>
<td>3.75</td>
<td>3.75</td>
</tr>
<tr>
<td>Max Voltage (V)</td>
<td>4.35</td>
<td>4.35</td>
</tr>
<tr>
<td>Nominal Capacity (mAh)</td>
<td>17</td>
<td>45</td>
</tr>
<tr>
<td>Thickness (mm)</td>
<td>0.43</td>
<td>0.43</td>
</tr>
</tbody>
</table>