1989: Founded as a R&D company focused on Lithium-ion polymer technology
>600 issued and pending patents worldwide

2002: New management team from Dell, emphasis on Sales and Marketing

2003: Launched Saphion® Lithium-ion technology: First phosphate based battery chemistry on the market

2003: Launched first N-Charge™ Power System: Consumer product showcasing Saphion technology

2004: Launching K-Charge™ & U-Charge™ Power System: Large format energy storage system.

2004: Move into the cell pack markets with the IFR 18650 and P545 cells.

2004: Set up Valence owned powder plant and pack assembly factory in China

2004: Set up EMEA Sales Office, in Mallusk, N.Ireland

2006: Q1 Launch of U Charge high volume production
Valence Locations & Partners

- Advanced Labs, England
  Advanced Battery Research
  Employees: 4

- Mallusk, N.Ireland
  Sales, Engineering
  Employees: 5

- Henderson, Nevada
  Battery Test
  Employees: 20

- Austin, Texas, HQ
  Engineering, Sales
  Employees: 45

- Sinbon
  N Charge pack assembly

- Cell Pack Assembly Plant
  Suzhou
  Employees: 130

- Powder Plant
  Suzhou
  Employees: 50

- Battery OEM
  China
  Li-polymer cells
  Cylindrical cells

- System Engineering
  Shanghai
  Employees: 30

Valence Confidential
Saphion Technology & Safety
The PO₄ advantage

In LiCoO₂:
- Co-O: 1.91 Å
In Saphion:
- P-O: 1.63 Å

Coordination and location determine bond distance and strength.

Tightly bound Oxygen = safety
Raman Spectroscopy stretching bands:

- **P-O**: 1100 cm⁻¹
- **Co-O (LCO)**: 540 cm⁻¹

The P-O bond is stronger than the Co-O bond.
LiFePO₄ vs. LiCoO₂: DSC

LiCoO₂: large exotherm onset at 147°C results in cell safety problem
LiFePO₄ exotherm smaller and onset at much higher temperature

Li₀.₅CoO₂ → 0.₅LiCoO₂ + 1/6Co₃O₄ + 1/6O₂
Co₃O₄ → 3CoO + 1/₂O₂

JES 146(9) Maleki et al. (Motorola): commercial LiCoO₂/graphite cell charged to 4.2V

JES 148(3) Yamada et al.
Various Chemistries Reactivity

Theoretical basis for safety advantages of phosphates
Phosphate Safety Comparison Video

http://www.valence.com/SafetyVideo.asp

Phosphate remains thermally stable under extreme abuse

Valence Confidential
## Abuse Test

**Abuse Requirements**
UL1642  Third Edition (april 26, 1995), latest amendment Jun 24, 1999

### Test Description

#### Saphion LCO

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
<th>Saphion</th>
<th>LCO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical Tests</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>section 10 short circuit test</td>
<td>at room temp connect terminals with wire &lt;0.1mOhm</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>at 60C connect terminals with wire &lt;0.1mOhm</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>section 11a Abnormal Charge</td>
<td>3 times recommended charge rate for 48hr minimum</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td><strong>Mechanical Tests</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>section 12 crush</td>
<td>applied load of 13kN between flat plates</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>section 13 impact</td>
<td>drop 20lbs from 2 ft onto 5/8in diameter bar</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>section 14 shock</td>
<td>75G initial, 125-175G peak</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>section 15 vibration</td>
<td>ramp 10-55-10Hz in 90 minutes, 1.6mm excursion</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td><strong>Environmental Tests</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>section 18a heating (hot box)</td>
<td>ramp to 150C, hold for 10 minutes</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>section 18b temperature cycling</td>
<td>ramp temp between -40 and 70C, 10X</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>section 18c altitude simulation</td>
<td>6hrs at 11.6kPa</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td><strong>Abuse Characterization</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nail Penetration</td>
<td>JSBA standard</td>
<td>Pass</td>
<td>Fail</td>
</tr>
<tr>
<td>Round Bar Crush</td>
<td>slow crush to deform cell to induce short</td>
<td>Pass</td>
<td>Fail</td>
</tr>
<tr>
<td>Series/Parallel testing</td>
<td>simulate proposed battery design</td>
<td>Pass</td>
<td>Fail</td>
</tr>
<tr>
<td>3 parallel Nail penetration</td>
<td>do safety devices in cell stop propagation</td>
<td>Pass</td>
<td>Fail</td>
</tr>
<tr>
<td>4 series NP on during charge</td>
<td>do safety devices in cell stop propagation</td>
<td>Pass</td>
<td>Fail</td>
</tr>
<tr>
<td>Hot Box (extended)</td>
<td>UL hot box with 150C hold</td>
<td>Pass</td>
<td>Fail</td>
</tr>
<tr>
<td>additional failsafe testing</td>
<td>application test to fail</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Valence Confidential**
Round Bar Crush Test

Round Bar Crush Test - Oxide18650
S/N 162153 - Temperature vs. Voltage

- Cell vented with heavy sparks and heavy smoke.

Round Bar Crush Test - Phosphate18650
S/N 341387 - Temperature vs. Voltage

Valence Confidential
Excess Lithium in cobalt cells causes cell to continue to charge until “safety” device is activated. Despite this activation, the cell goes into thermal runaway 15 minutes later, reaching 760°C.

Saphion® cells have NO excess lithium. After fully charging, the cell quickly reaches the 5V setpoint and the current tapers. The temperature reaches only 50°C.
Nail Penetration Test

Nail Pen Test - Oxide 18650’s
S/N 204040 - Temp. vs. Voltage, Current

Nail Pen Test - Phosphate 18650’s
S/N 341488 - Temp. vs. Voltage, Current

3 cells in parallel with cells mounted side by side numbered 1-3 from left to right.
Nail Pen cell #2.

Nail penetrated cell
Valence Products
Products and Segments

**Portable Power**
50 – 300 Wh

**Motive Power**
500 – 85000 Wh

**Backup Power**
KWh - MWh

- **OEMs and Pack Builders**
- **Cells**
- **N-Charge**
- **U-Charge**
- **K-Charge**

**Watt Hours**

Valence Confidential
A family of power sources to facilitate complete mobility

Sleek polymer models for thin and light notebooks

Modular and scaleable models for DTR and mainstream notebooks

Lightweight and compact for ultimate portability

Uses notebook PC adapter for recharging

Provides fast recharge and long cycle life
A lightweight, high-energy alternative to conventional lead acid batteries designed for wheelchairs, scooters, ebikes and more…

High performance, intelligent, reliable batteries

Safe, environmentally friendly, Saphion® Lithium-ion technology

Low maintenance, long cycle life = Lower lifetime costs!

Twice the runtime and 1/3 less weight compared to Lead Acid

Fits easily into established 12V and 24V platforms
K-Charge™ Power System

*Kilowatt to megawatts of energy storage for the utility, network and vehicular markets*

High performance, intelligent, reliable batteries

The safest Lithium-ion technology available

Flexible form factor

Less volume and lower weight

Fast recharge time, excellent cycle life
Valence Technology
& Segway
### Segway Pack Technical Data

<table>
<thead>
<tr>
<th>Max Dimensions (l x w x h) mm</th>
<th>360 x 150 x 82</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>5.5 kgs</td>
</tr>
<tr>
<td>Cell Used</td>
<td>Valence Saphion IFR 18650e</td>
</tr>
<tr>
<td>Number of cells per pack</td>
<td>92</td>
</tr>
<tr>
<td>Pack Capacity</td>
<td>400 Wh</td>
</tr>
<tr>
<td>Continuous Current</td>
<td>16 Amps *</td>
</tr>
<tr>
<td>Peak Current</td>
<td>30 amps</td>
</tr>
</tbody>
</table>

* Rated value, however 30A continuous has been tested with no ill effects.

Valence Confidential