Supporting the deployment of safe Li-ion stationary batteries for large-scale grid applications

Presentation of material selection protocol

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Key megatrends for Umicore

- Resource scarcity
- More stringent emission control
- Renewable energy
- Electrification of the automobile
Global leader in key materials for rechargeable batteries

Umicore RBM has already produced cathode materials to...

....provide a smartphone to every person on this planet

....power more than 1 Million EV's
Cathode Material Choice Strongly Determines Characteristics & Performance of Li-Ion Batteries

Umicore is integrated along the Li-ion battery value chain

Application know-how enables Umicore to support end-user in terms of:

- Performance
- Overall system cost
- Product development
- Future roadmaps
Report on methodology for selecting appropriate cathode/anode materials

Choice of appropriate active material couple

Figure 1: Energy diagram of battery Materials (Source: Copyright: Dispatch Energy Innovations GmbH)
From LIB Characteristics to Active Materials

Breakthrough materials are first tested in PE and xEV markets

- **Frequency regulation, Windturbines**
  - High discharge rate
  - NMC, LFP Power

- **Load leveling, PV, Arbitrage**
  - Low cost per cycle
  - EV type NMC, LFP Energy

- **Power quality, Primary reserve**
  - High Power
  - HEV type NMC, NCA

- **Capacity credit, Energy back-up**
  - High Calendar life
  - NMC, NCA

15min – 1h storage

4h – 8h storage
D4.1 - Report on methodology for selecting appropriate cathode/anode materials
Tests done a cell level @ Umicore Applied Tech labs (1Ah)

Reliability / Safety characteristics of couples

- NMC 111 / Graphite: 100,0%
- NCA PSD + / Graphite: 80,0%
- NCA PSD - / Graphite: 60,0%
- Low Cobalt NMC PSD + / Graphite: 40,0%
- Low Cobalt NMC PSD ++ / Graphite: 20,0%
- Low Cobalt NMC PSD +++ / Graphite: 0,0%
- High Nickel NMC PSD: 0,0%
- High Nickel NMC PSD ++ / Graphite: 20,0%
- High Nickel NMC PSD +++ / Graphite: 40,0%
- NMC 111 /LTO: 60,0%
- LFP Power / Graphite: 80,0%
- NCA PSD + / Graphite: 20,0%
- NCA PSD - / Graphite: 0,0%
- Low Cobalt NMC PSD + / Graphite: 0,0%
- Low Cobalt NMC PSD ++ / Graphite: 20,0%
- High Nickel NMC PSD: 40,0%
- High Nickel NMC PSD ++ / Graphite: 60,0%
- NMC 111 /LTO: 80,0%

Graphical representation of safety test results:

- Bulging properties (90°C/4hr) - Lower growth of cell thickness
- High temperature storage (60°C/3 months) - Lower DCR Increase after three months
- Temperature properties - Capacity at 60°C vs 25°C at 0,5 C
- Bulging properties (90C/4hr) - Lower DCR growth after 4 hours
Three pillars for selection:

- **Safety** or reliability test to identify safest materials
- **Price** analysis of less expensive active materials
- Convert **end-users needs** and complete systems characteristics to battery and materials characteristics.

Methodology to select best suited active materials for LIB ESS systems
Closing the loop via battery recycling

Umicore Battery Recycling

Recycling of LIB cells, packs, production scrap

- Global drop-off points for collection of spent material
- Recycling installation in Hoboken, Belgium
  - Capacity: 7000 mT p.a.
  - Excellent energy- and CO₂-balance
- Selected partner for Tesla and Toyota
- Re-using metals reduces market dependency
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Thank you!
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