Li ion battery material market trends past and future

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Presentation Outline
• The Li-ion battery market in 2010
• The Li-ion battery value chain
• Li-ion battery material market
• Forecasts & conclusions

AABC Europe 2011
6-10 June
Mainz, Germany
Information for Growth

Powering your company’s market strategy with in-depth research

- Creation: 1992
- Headquarter: Paris
- Liaison Office: Japan, USA
- Director: M. Madani
- AVICENNE Energy Director: C. Pillot
- 4 consultants in Paris

AVICENNE ENERGY

The Rechargeable Battery market 2010-2020
April 2011, 20th Edition

Customized Client Projects

AVICENNE MEDICAL
METHODOLOGY: EXTENSIVE FIELD RESEARCH TO RETRIEVE & CROSS CHECK INFORMATION

Top management contact network

Conferences & Exhibitions

In Depth analysis Of applications

Cross Check Analysis

Battery Makers

Substitution technologies: SuperCap, Fuel cells

Battery Users, OEM

Safety

Raw materials suppliers

Environment & recycling

AABC EUROPE 2011 - JUNE 6 - 10 - Mainz, GERMANY
OUTLINE

1. THE LI-ION BATTERY MARKET IN 2010
2. THE LI-ION BATTERY VALUE CHAIN
3. LI-ION BATTERY MATERIAL MARKET
4. FORECASTS & CONCLUSIONS
THE WORLDWIDE BATTERY MARKET
1990-2010

30 BILLION US$ & 3-4% AVERAGE GROWTH PER YEAR (1990-2010)

<table>
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<tr>
<th>Year</th>
<th>Billion $</th>
<th>Li-ion</th>
<th>NiMH</th>
<th>NiCD</th>
<th>Lead Acid</th>
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WORLDWIDE RECHARGEABLE BATTERY MARKET (M$)

Battery sales, M US$, Worldwide, 2000 - 2010

CAGR 00/10: +10%
CAGR 00/10: +3%
CAGR 00/10: -7%

Battery sales, M US$, Worldwide, 2000 - 2010

- HEV
- Others
- Power tools
- Portable PCs
- Cellular Phones

NiCd | NiMH | Li-ion
WORLDWIDE RECHARGEABLE BATTERY MARKET (MWh)

The worldwide rechargeable battery market, MWh, 2000-2010

MWh

CAGR 00/10: +26%
CAGR 00/10: +2%
CAGR 00/10: -1%

Ni-Cd | Ni-MH | Li-Ion

1995 | 2000 | 2005 | 2010

Automotive | Others | Power Tools | Portable PCs | Celluluar Phones

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LI-ION IN 2010

MAIN APPLICATION: CELLULAR, NOTEBOOK

3 800 M Li-ion cells – 22 500 MWh
8 000 M$

CAGR 2005/2010:
+21% per year in volume
+10% per year in value

Li-ion Battery sales,
M$, Worldwide, 2000-2010

[Graph showing Li-ion Battery sales from 2000 to 2010, with categories for Cellular Phones, Portable PCs, and Others.]

Li-ion Battery sales,
M$, Worldwide, 2000-2010

[Graph showing Li-ion Battery sales from 2000 to 2010, with categories for Power tools, Digital camera, Games, Camcorders, MP3, and Others.]
LIB VALUE CHAIN IN 2010

- **CATHODE SUPPLIERS**
  - 44 000 T
  - Revenues: 1.6 B$
  - Gross Margin: 20-25%

- **ANODE SUPPLIERS**
  - 24 000 T
  - Revenues: 0.5 B$
  - Gross Margin: 30-35%

- **ELECTROLYTE SUPPLIERS**
  - 15 000 T
  - Revenues: 0.3 B$
  - Gross Margin: 35%

- **SEPARATOR SUPPLIERS**
  - 300 M m²
  - Revenues: 0.5 B$
  - Gross Margin: > 40%

- **ANCILLARY**
  - Revenues: 0.5 B$

- **CELL MANUFACTURERS**
  - Revenues: 8 B$
  - Gross margin: <10%

- **PACK MANUFACTURERS**
  - Revenues: 9.5 B$
  - Gross margin: <10%

-> Cell makers & raw material suppliers relationship
-> Raw material new entrants
-> Entry barriers for raw materials suppliers
-> Raw material impact on battery efficiency
-> Raw material cost and main trends

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CATHODE ACTIVE MATERIALS

CATHODE SUPPLIERS

44 000 T
Revenues: 1,6 B$
Gross Margin: 20-25%

Cathode active materials for Li-ion & Pol batteries, in Tons, 2000-2010

Assumptions

200 000 EV in 2015
1 M in 2020
100% Li-ion

0.1 M P-HEV in 2015
0.4 M in 2020
100% Li-ion

2,2 M HEV in 2015
3.5 M in 2020
35% Li-ion in 2020

Cathode active materials suppliers market share, in volume, 2010

- Nippon Chemical 3%
- Seimi Chemical 2%
- Nichia Corp 24%
- L&F 2%
- Umicore Korea 27%
- Others 16%
- Tanaka chem 2%
- BYD 3%
- Matsushita 3%
- Chinese local 12%
- Toda Kogyo Corp 6%

SOURCE : THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011
ANODE SUPPLIERS
24 000 T
Revenues: 0.5 B$
Gross Margin: 30-35%

Anode active materials by type, in volume, 2006 - 2010

- Si or Sn Type
- Low cristalinity
- Amorphous Carbon
- Meso-Phase
- Artificial Graphite
- Natural Graphite

Anode active materials suppliers market share, in volume, 2010

- Hitachi Chemical 34%
- Nippon Carbon 19%
- Shenzhen BTR 12%
- Mitsubishi Chemical 4%
- JFE Chemical 8%
- Others 23%

SOURCE: THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011
THE SEPARATOR FOR LIB MARKET

SEPARATOR SUPPLIERS
300 M m²
Revenues: 0,5 B$
Gross Margin: > 40 %

The LIB separator market worldwide in value
(M $) 2000-2010
CAGR 2000/2010: +18%

The LIB separator market worldwide in value (M $) 2010 by competitors

SOURCE : THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011
THE ELECTROLYTE FOR LIB MARKET

ELECTROLYTE SUPPLIERS
15 000 T
Revenues: 0.3 B$
Gross Margin: 35%

Electrolyte suppliers, market shares in 2010

Electrolyte suppliers & battery makers relationship in 2010

- Others
- Lishen
- BYD
- LG Chem
- SDI
- Panasonic
- Sony
- Sanyo

Tons

- UBE
- Mitsubishi
- Tomiyama
- Zhangjiagang Guotai-Huarong
- Others
- CHIEL
- In-house
- Tomiyama

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LONG TERM HEV FORECAST FROM 3 TO 8 M HEV IN 2020

HEV FORECASTS (Million)

- AVICENNE (Oct 2009)
- Deutsche Bank (June 2008)
- Deutsche Bank (Nov 2009)
- IIT (March 2010)
- Credit Suisse
- Nomura (March 2009)

SOURCE: AVICENNE COMPILATION, MARCH 2011
LI-ION PENETRATION IN VARIOUS DEVICES
AVICENNE & OTHER ANALYSTS FORECAST

Cellular Phones
(to = 1994)

Portable PCs
(to = 1994)

Power Tools
(to = 2004)

Li-ion penetration in electronic devices & HEV

YEARS

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

SOURCE: AVICENNE COMPILATION, MARCH 2011

(1) AVICENNE HEV Forecasts, march 09, Relevant scenario
(2) AVICENNE HEV Forecasts, march 09, Li-ion Optimistic scenario
(3) IIT, TAKESHITA, March 08, THE 25th INTERNATIONAL BATTERY SEMINAR & EXHIBIT, Slide 8 & March 2009, 26th Battery Seminar, Slide 5
LI-ION BATTERIES DEVELOPMENTS FOR HEV, P-HEV & EV

- Li-ion is **THE** solution for the future
- BUT, SAFETY, LIFE TIME & COST issues
- Lot of technical solutions (NMC, NCA, LFP, LCO...)
- Lot of EXPENSIVE Developments...

So,
- Lot of JV, partnerships etc...

### JOINT VENTURE & STRONG PARTNERSHIP

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LI-ION BATTERY COST

LI-ION BATTERY COST
CELLS / PACK

$ / kWh

Cell
Pack

Li-ion 18650 cell
Portable PC Pack
Li-ion Prismatic Cell
Cellular Phone Pack
HEV Cell (2015)
HEV Pack (2015)
EV Cell (2015)
EV Pack (2015)

LI-ION BATTERY PACK COST FOR EV
AVICENNE FORECASTS

$ / kWh

Cell
Pack

BMS
Pack Cost
Cell Cost
Other Materials
Cathode

2015*
2020**

* For Production > 100,000 packs/year
** USBAC Goal in 2020

Source: AVICENNE Compilation, March 2011

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HEV, P-HEV & EV LONG TERM FORECASTS
EV ENERGY NEED: 25 MORE THAN HEV!

EV
P-HEV
HEV
E-bikes
Power Tools
Portable PC
Mobile Phone

Average Wh per device

EV sold, in million units, worldwide, 2010 - 2020

SOURCE: THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011
TOTAL LIB DEMAND

Assumptions:
- 200,000 EV in 2015
  1M in 2020
  100% Li-ion
- 0.1 M P-HEV in 2015
  0.4 M in 2020
  100% Li-ion
- 2.2 M HEV in 2015
  3.5 M in 2020
  35% Li-ion in 2020

EV, HEV & P-HEV Battery needs (M Wh)
2005 – 2020 (Scenario 2)

Total battery demand (M Wh)
2005 – 2020

SOURCE: THE RECHARGEABLE BATTERY MARKET 2010-2020, AVICENNE, MARCH 2011
Li-ion battery is driven today by Portable PCs & electronic devices

For automotive, the battery technology is today the NiMH, we don’t expect the Li-ion to be significant on the HEV mass market in the next few years

P-HEV & EV will be powered by Li-ion

1 M EV represent roughly 20 000 MWh, or 40 000 tones of cathode materials!

1M EV represent from 3 to 5 Billion US$ revenues for Li-ion materials

EV expectations attract now large Chemical companies

New materials are needed to meet Automotive standards