北京大学
PEKING UNIVERSITY

Energy Storage and Power Lithium Batteries

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College of Chemistry and Molecular Engineering,
Peking University

Outline

- ☐ Research Fields and Interests
- ☐ Progress of our research work
- ☐ Progress on Industrialization
- ☐ Application

Research Fields and Interests

Research Field:

Energy materials and devices, currently focusing on LIBs cathode materials and technology related to lithium ion battery.

Research Direction:

R&D of novel materials and systems with high safety, low cost, and long life for energy storage and transformation.

Outline

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- ☐Progress of our research work
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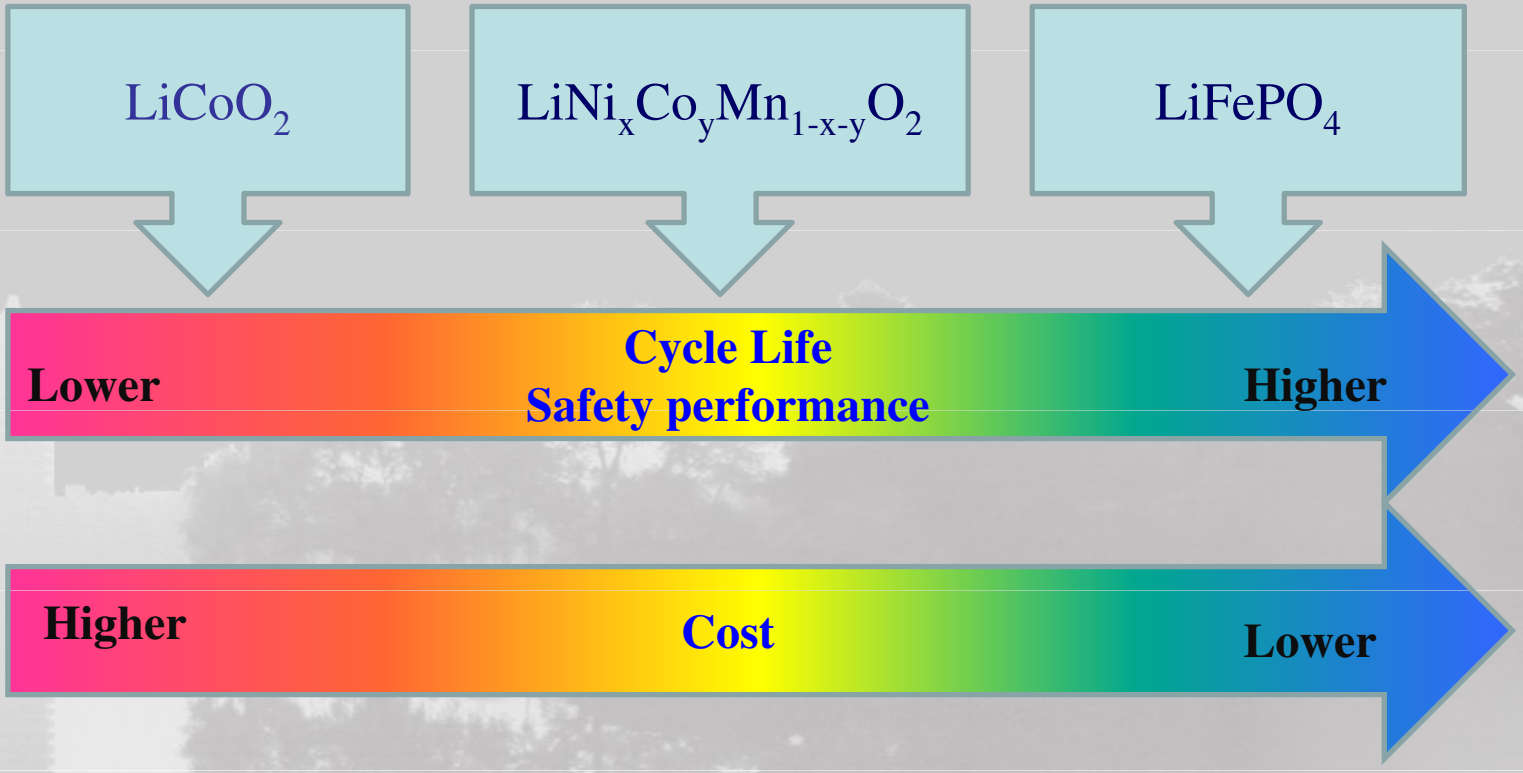
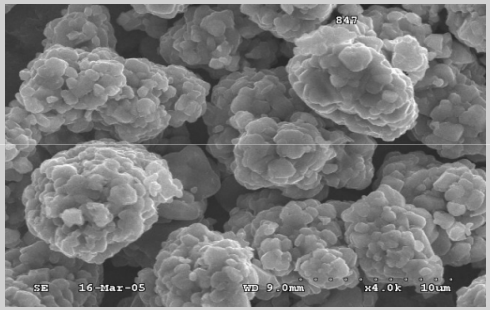
Materials with research interest



Research on $LiCoO_2$—For Mobile Phone&NB



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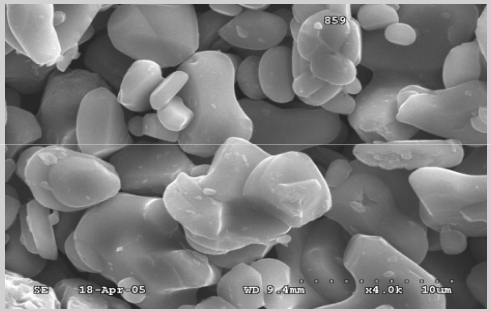

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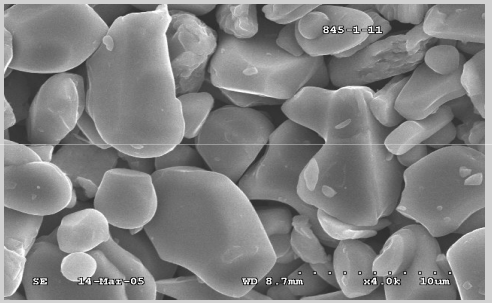

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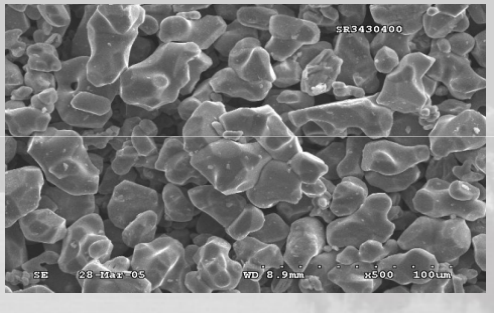

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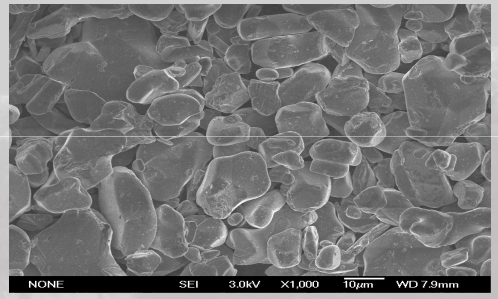

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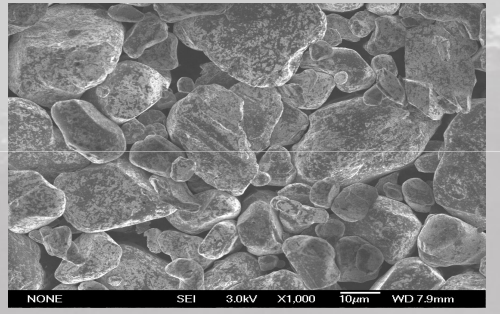
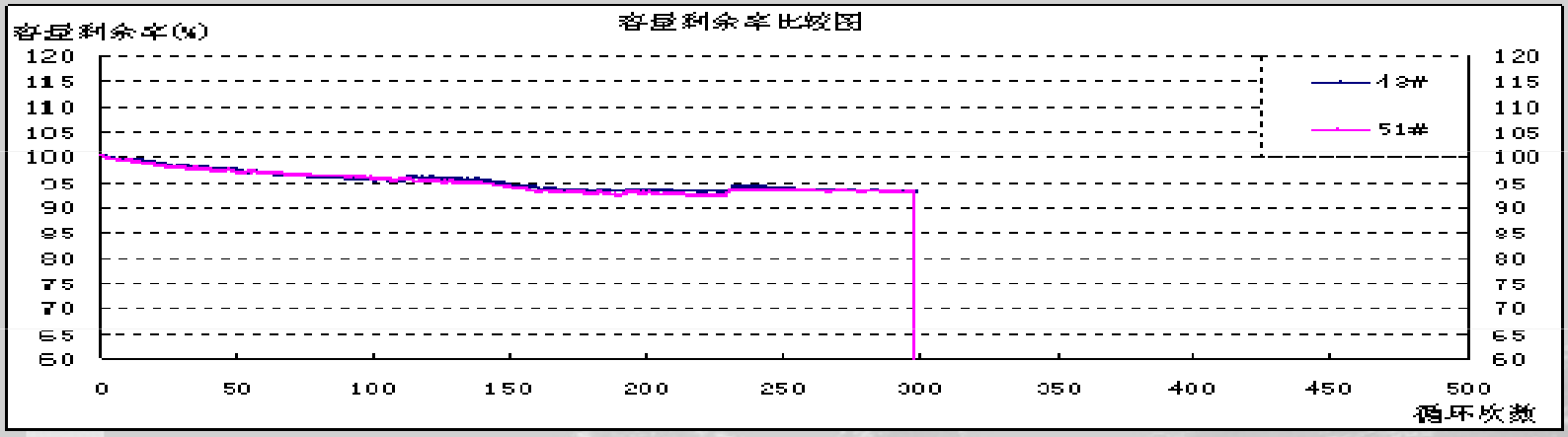


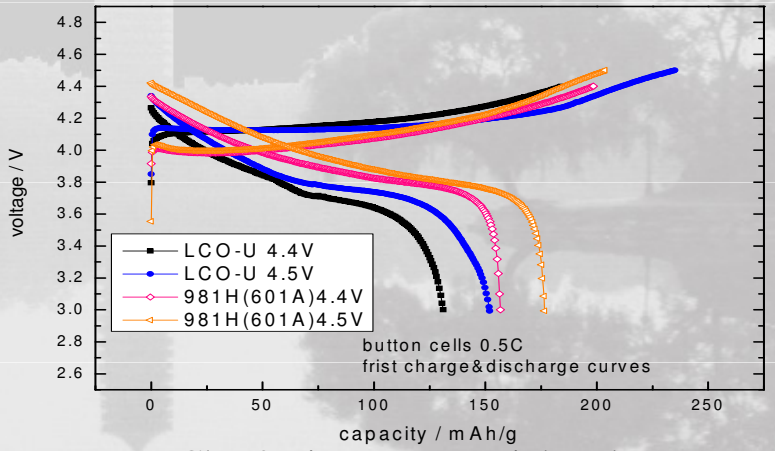
982H

Coat ing and Doping: Big Particle size, High Tap, Good safety, Long cycle life

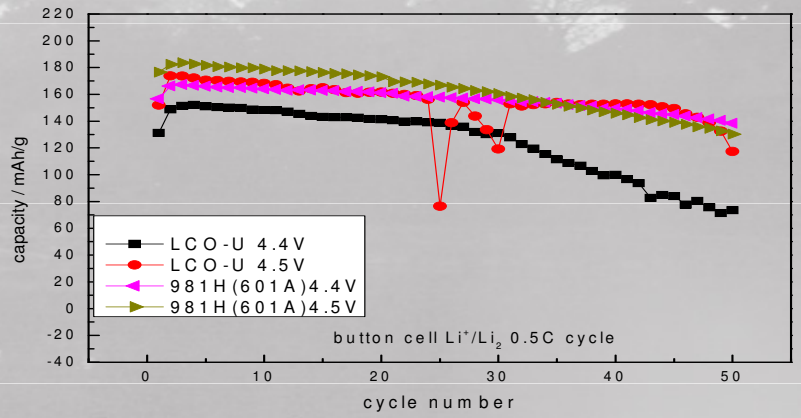
Good Performance of $LiCoO_2$ products



Cycle performance at RT

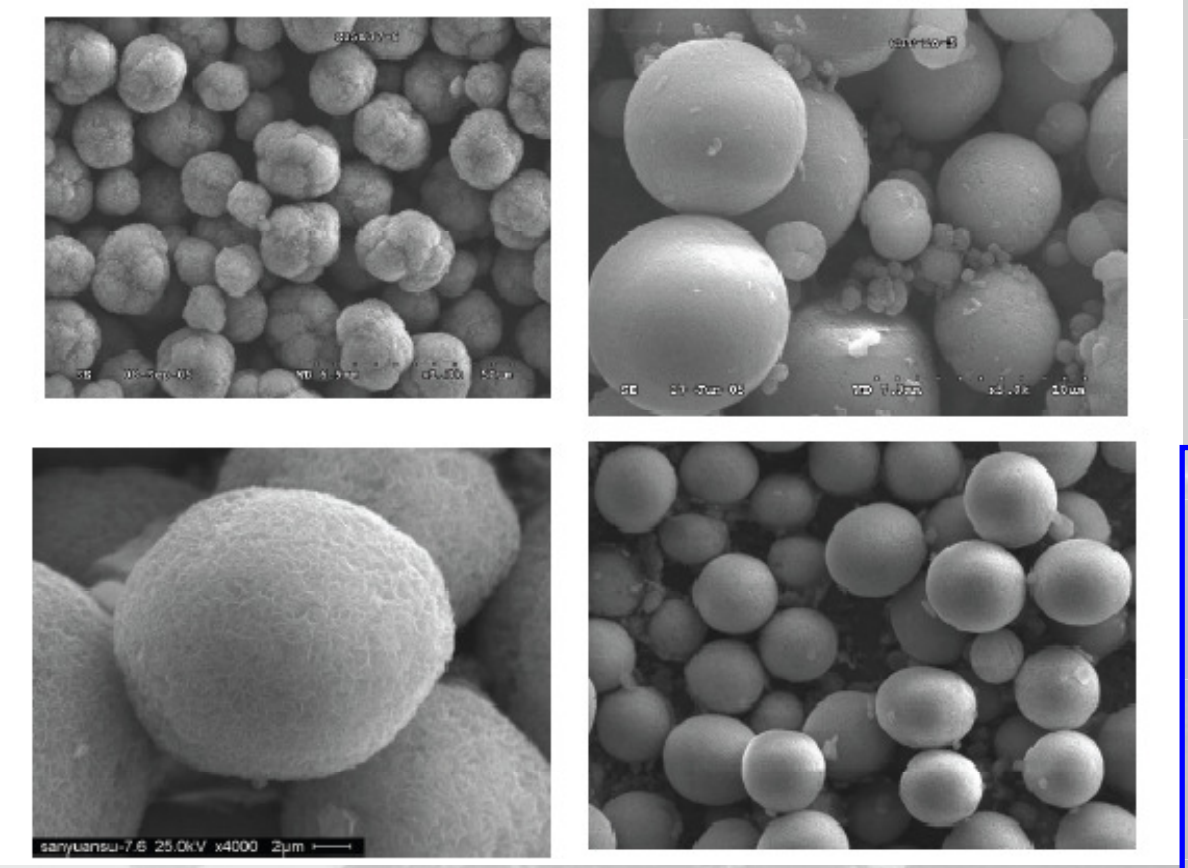


Char&Dis curves at High Voltage



Cycle Performance at High Voltage

Research on $LiNi_xCo_yMn_{1-x-y}O_2$ (NCM)



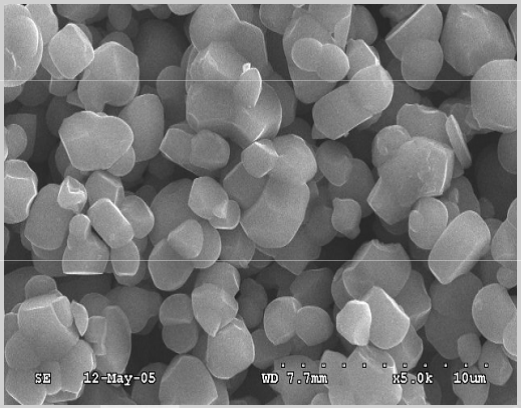
Advantages

- ☐ Higher Safety
- ☐ Lower Cost
- ☐ Higher capacity

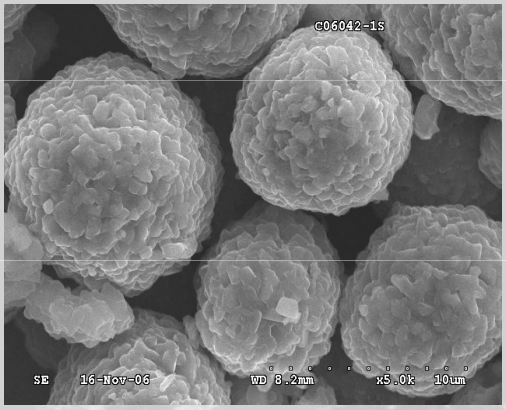
Difficult to synthesize:

We have synthesized spherical morphology NCM precusor by controlled synthesis method, which can make Ni, Co, Mn 3 elements mixed homogeneously.

Synthesis of different type NCM cathode materials



PU-10



PU-20

PU-30

PU-50

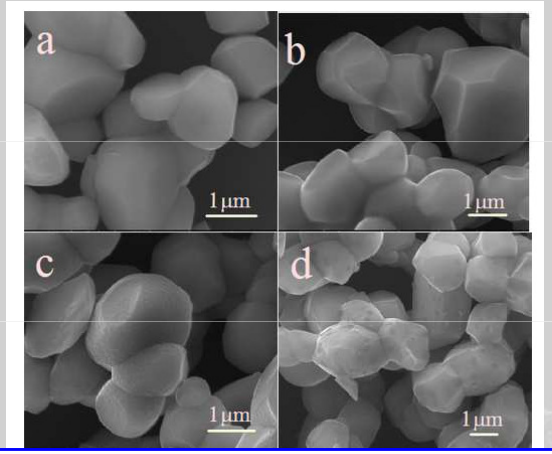
Different morphology

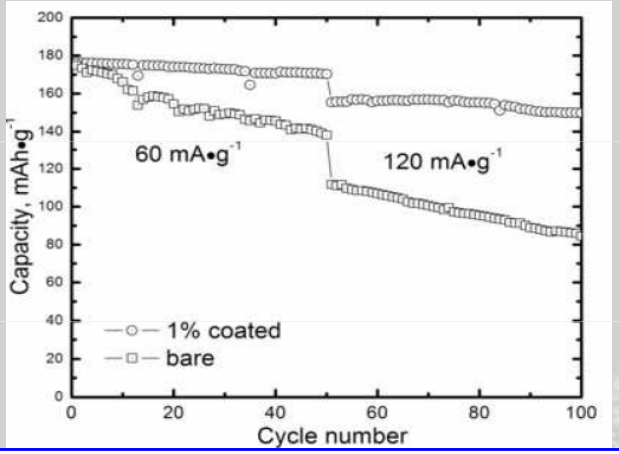
$LiNi_{0.4}Co_{0.2}Mn_{0.4}O_2$

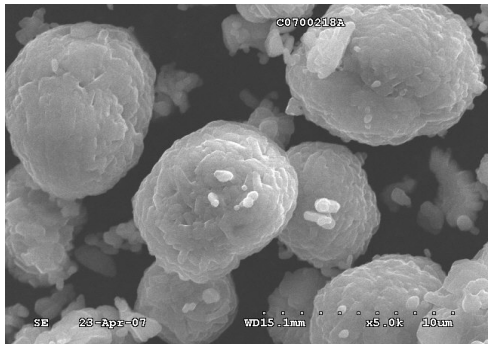
$LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$

$LiNi_{0.5}Co_{0.2}Mn_{0.3}O_2$

Surface modification of NCM







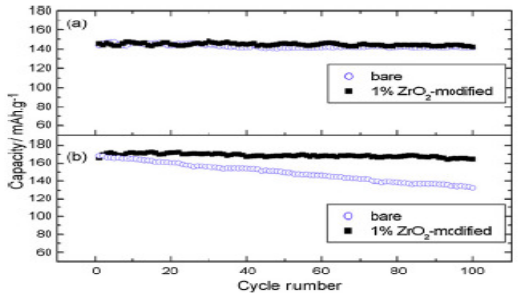


Fig. 7. Cycle performance comparison between bare material and 1% ZrO_2-modified $Li(Ni_{1/3}Co_{1/3}Mn_{1/3})O_2$ at 0.5C current charging and discharging in the voltage range of 4.3–3.0 V (a) and 4.5–3.0 V (b), respectively.

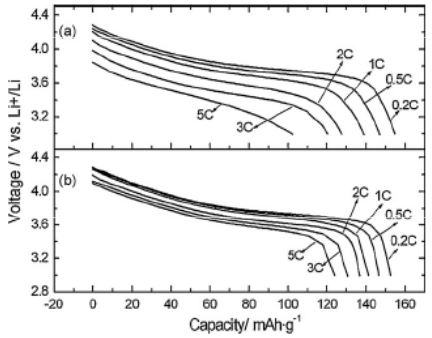
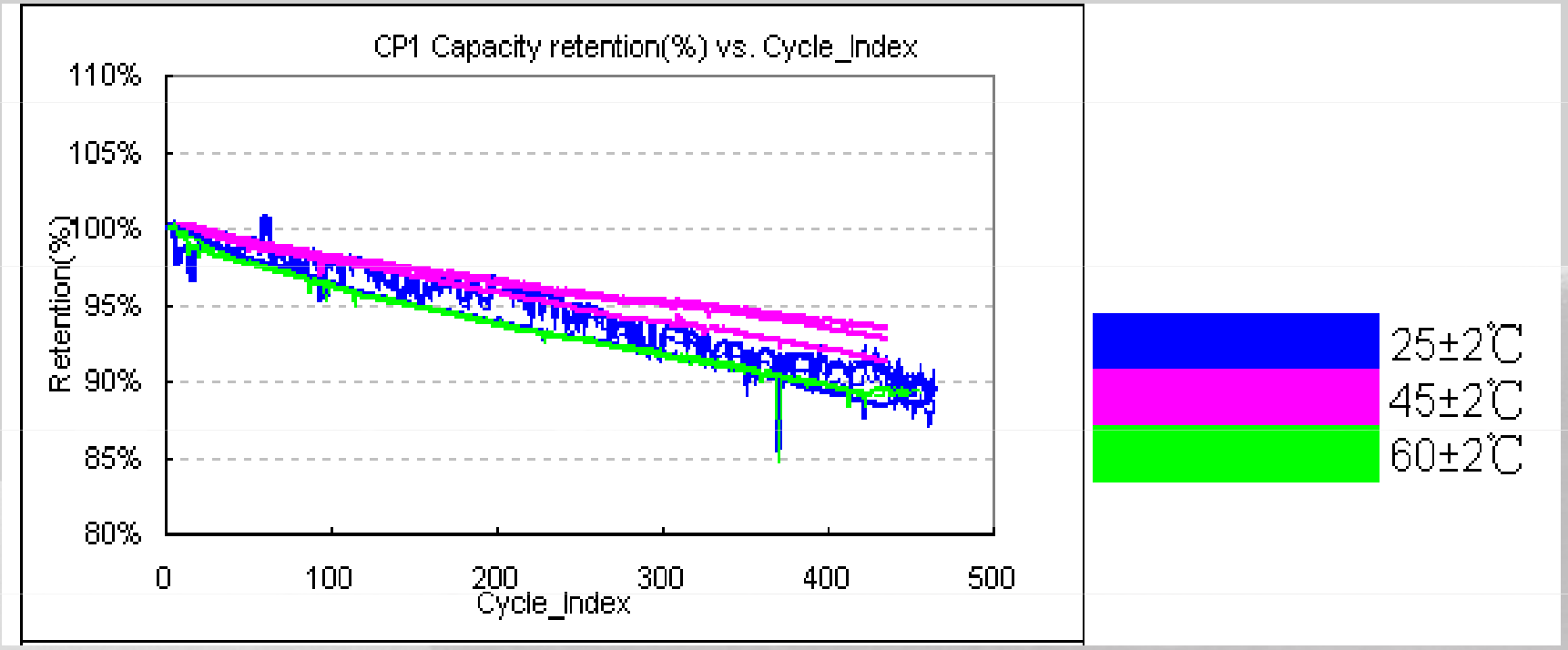


Fig. 8. Rate discharging capability of bare (a) and 1% ZrO_2-modified $Li(Ni_{1/3}Co_{1/3}Mn_{1/3})O_2$ (b).

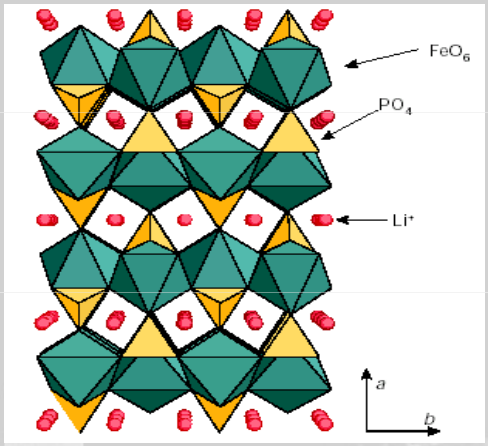
Ni JF,Zhou HH,Chen JT,Zhang XX. *Electrochimica Acta*, 2008,53(7),3075

Huang YY, Chen JT, Ni JF, Zhou HH*, Zhang XX. *Journal of Power Sources* 188 (2009) 538–545

Good Performance of NCM



Research on $LiFePO_4$



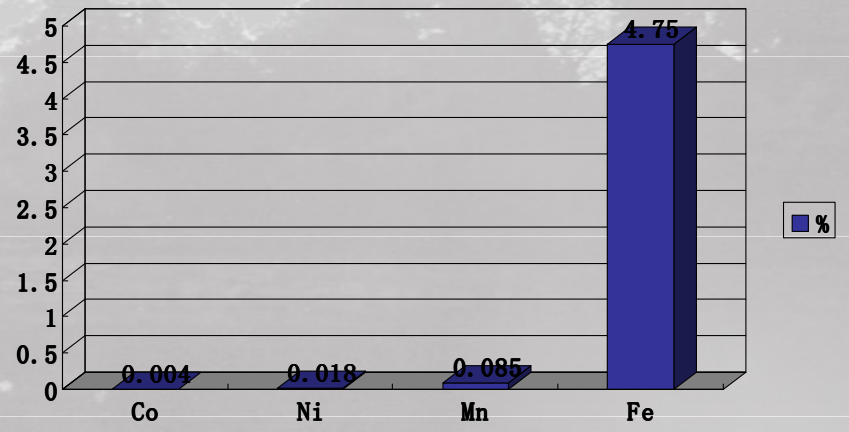
a. $LiFePO_4$ Structure
(Tarascon, Nature,2001,414:359)

Advantages

1、Good Structure Stability-Safety, long life;
2、Fe and Phosphates are abundant-Low cost;
3、Environmentally friendly-no toxic elements.

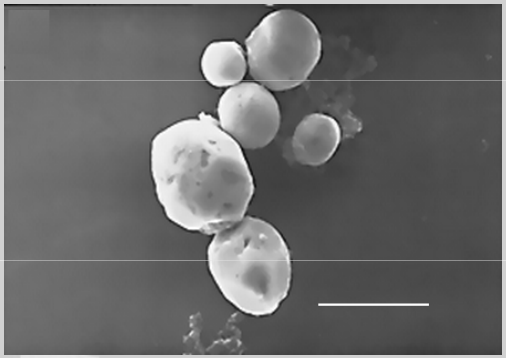
Disadvantages

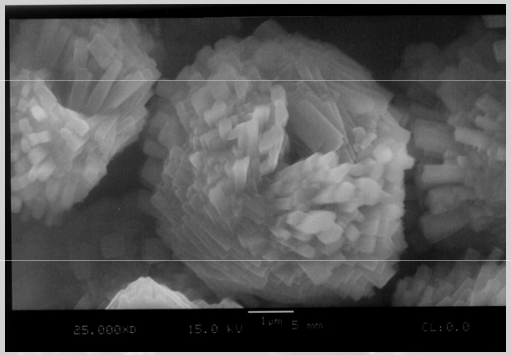
1、Slow Li-ion diffusion
2、Low electronic conductivity
3、Power power capability

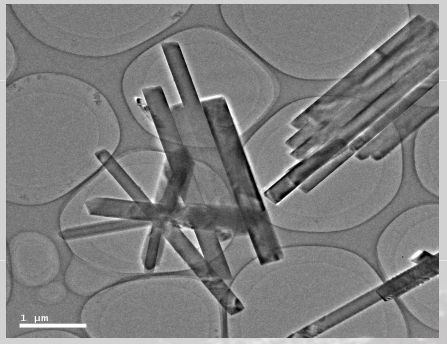


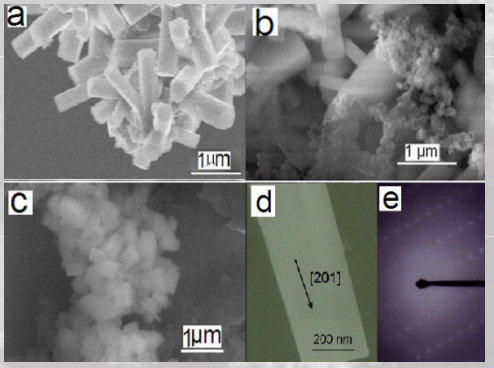
Compare of Dif. Elements content in the earth

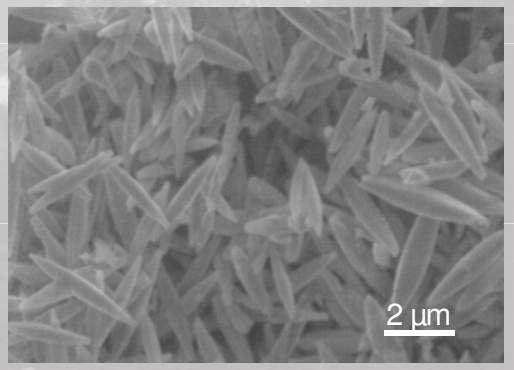
Morphology Control of LFP









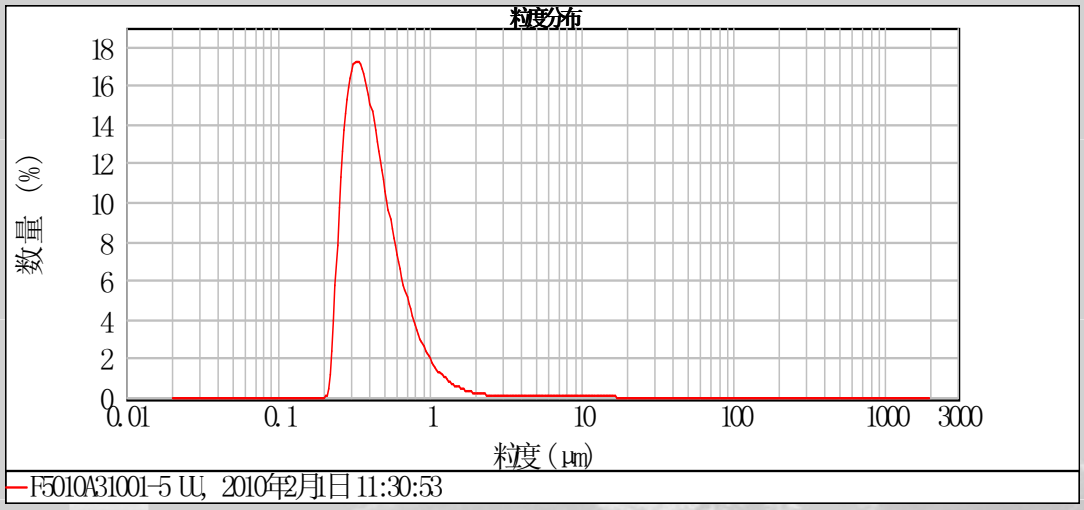


Materials Letters，61（3-4）：1260～1264，2007
Acta Physico-Chimica Sinica， 2007,23(6):830～834
China Patent: ZL 20061 0011378.7, 2008, *CN1821063，2007*

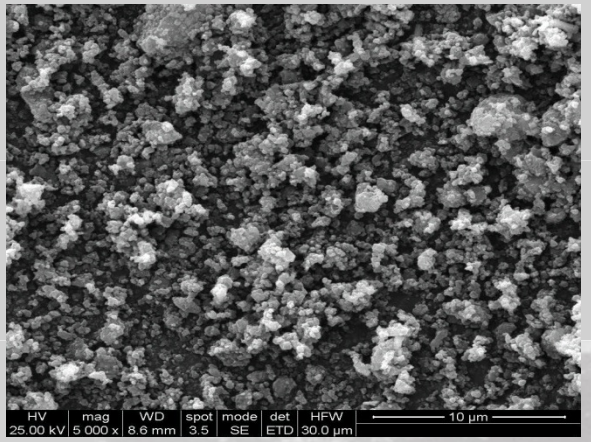
Properties of Different type LFP

指标	LFP-020	LFP-021	LFP-200	LFP-300	LFP-500
D_{50}(μm)	1.8	2.0	1.5	2.0	1.5
TD(g/cm$^{3)}$	1.2	1.2	1.3	1.4	1.4
SSA(m^2/g)	15	15	12	9	14
Press Density (g/cm^3)	2.1	2.1	2.2	2.2	2.3
0.1C Cap.	152	154	156	154	159
3.3V(0.1C)	88%	90%	95%	94%	96%
1C Cap.	138	136	144	143	147
3.3V(1C)	70%	65%	84%	82%	81%

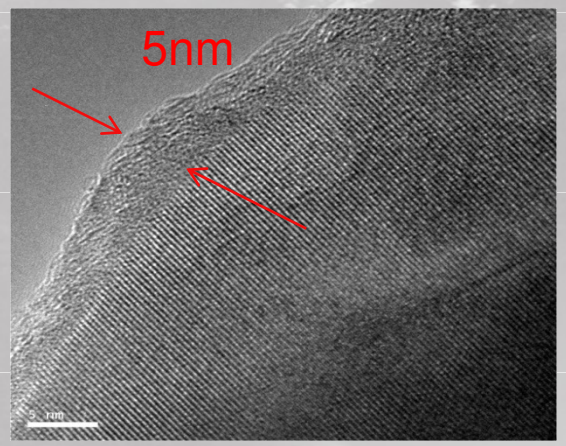
Property of LFP-500



PSD of LFP-500



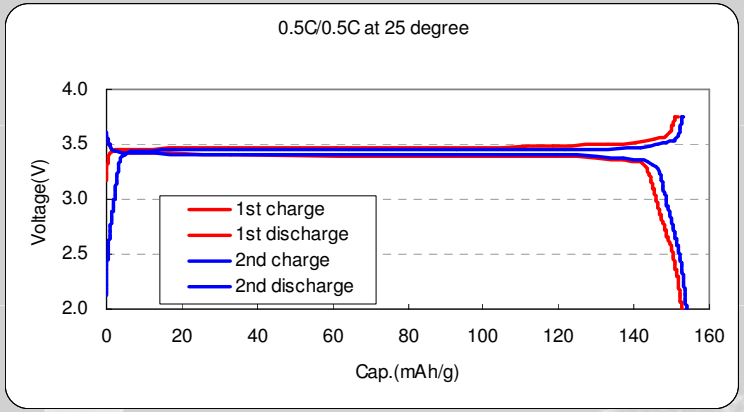
LFP-500 SEM



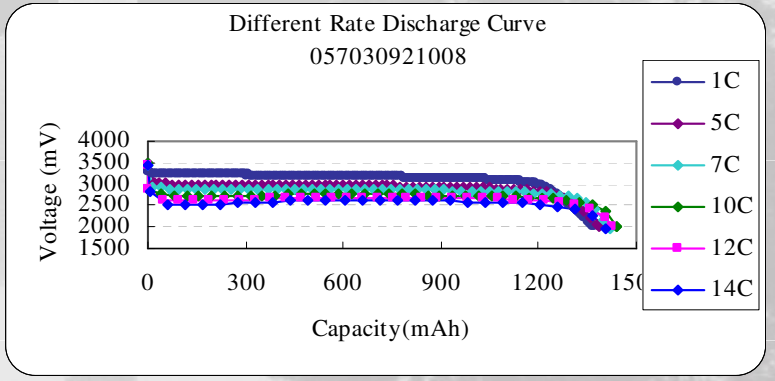
LFP-500 TEM

Narrow PSD
Uniform and thin Carbon coating layer

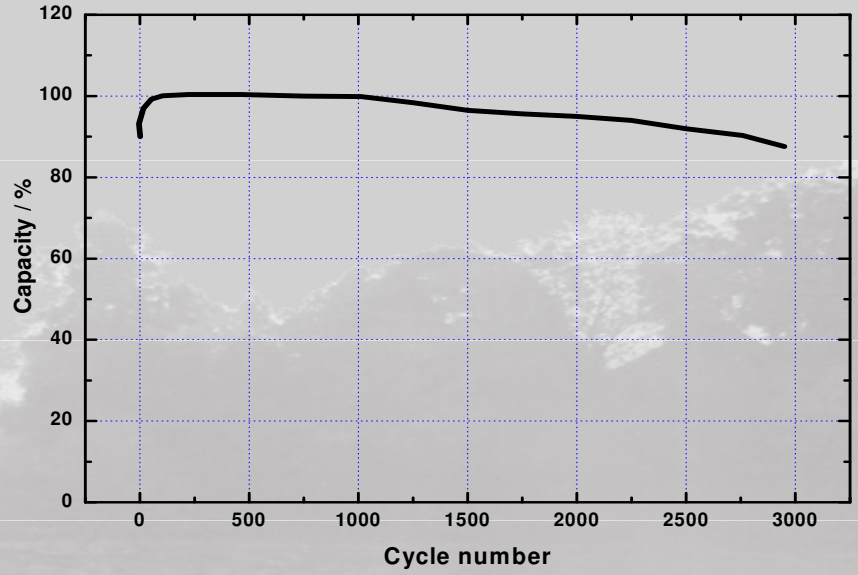
Good Electrochemical performance



Char&Dis curves

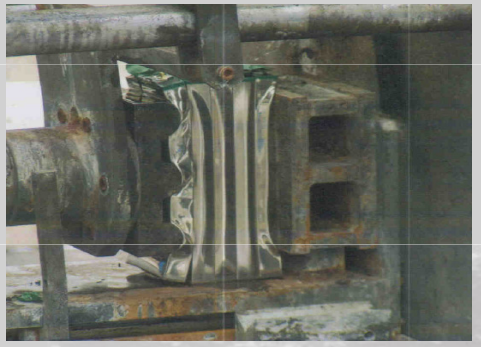


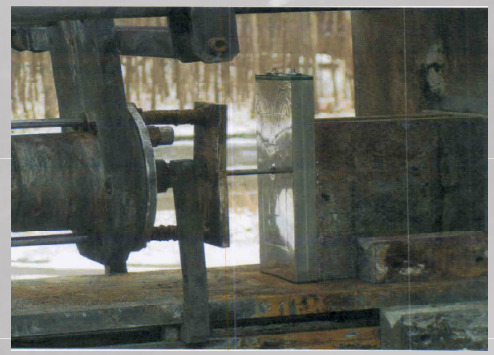
High Rate Performance



Cycle performance

Safety Performance test of LFP power batteries





Outline

- Background
- Progress of our research work
- Progress on Industrialization
- Application

Progress on Industrialization

- In Dec.1999, we founded a high-tech company -- **Pulead**, mainly engaged in production and sales of lithium ion batteries and electrode materials.
- Granted ISO9001:2000 Quality management system in May 2002, ISO14001:2004 Environment management system in Jan. 2006.

Changping Plant

Product Line of LFP

Progress on Industrialization

- In Jul. 2004, we founded the first subsidiary company-- **Tai'an Pulead** Company in Shandong, mainly engaged in production of LCO and NCM.

Tai'an Plant

Progress on Industrialization

- In Nov. 2009, we founded the second subsidiary company-- **Beijing Pulead Battery company,** mainly engaged in production of power Battery.

Pulead
BAGC
Foton
NVT

→ **Beijing Pulead**

Progress on Industrialization

- In Jan. 2010, We founded the third subsidiary company, **Qinghai Taifeng Pulead** company in Qinghai, mainly engaged in production of $LiFePO_4$ and high quality Li_2CO_3.

Layout Picture in Qinghai factory

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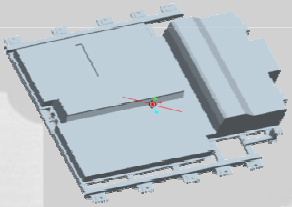
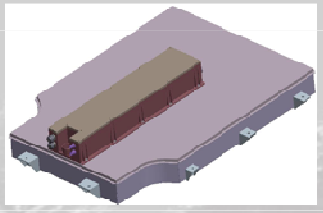
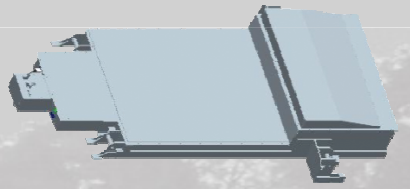
Beijing Sedan Projects

（2008– ）

BE701 (Sebring)





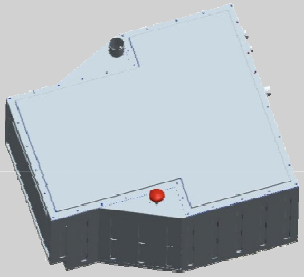


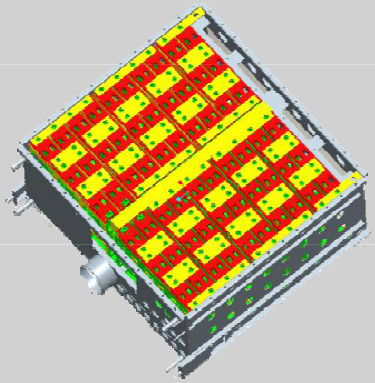
C60EV (Saab 9-3)

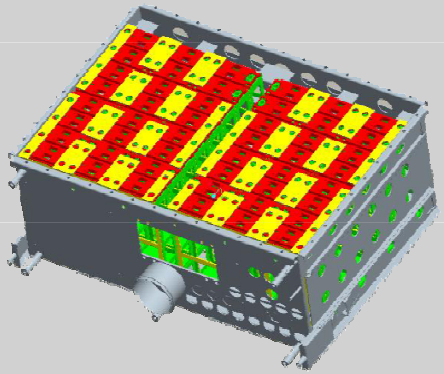
C71EV (Saab 9-5)

Beijing Street Sweeper Project

（2008- ）







2 tons 8 tons 16 tons

Demonstration project of cleaning trucks in Beijing

3 type:
Watering cart
Garbage truck
Road sweeper

Total: 30

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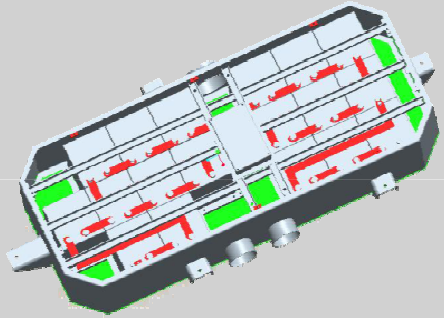
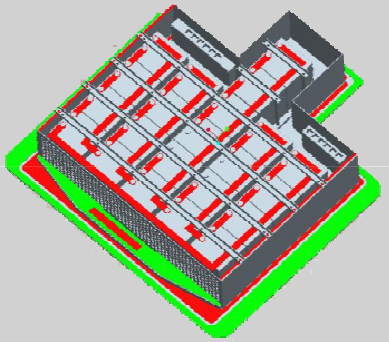
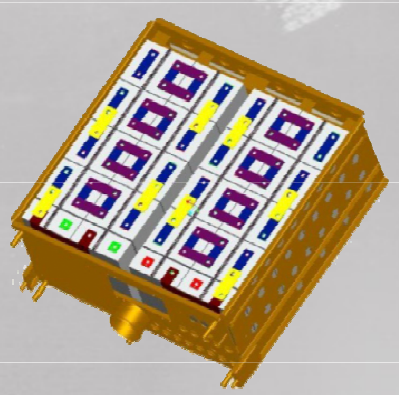
Other Ongoing Beijing Projects

（2008– ）

Midi EV - Taxi







City Bus

E-Bus Charge Station

E-Bus LFP Battery pack specifications :

- 396V/360Ah
- 10 packs/bus
- 120Ah Cell 3 parallel connection and 124series connection
- Battery weight : 1.6t
- Full charge duration:3h
- Battery exchange

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Energy Storage Battery Projects

Solar Energy Street Lamp demonstration projects for energy storage battery

Challenges in the Future

$$\frac{\text{Range (miles)} \times 300\ \text{Wh/mile}}{0.8\ (20\%\ \text{reserve capacity})}$$

= 15 kWh for 40 mile PHEV
= 75 kWh for 200 mile BEV
} *Energy*

Typical of current Li-ion

÷ 110 Wh/kg
= 136 kg for 40 mile PHEV
= 681 kg for 200 mile BEV
} *Mass (too heavy!)*

÷ 220 Wh/L
= 68 L for 40 mile PHEV
= 341 L for 200 mile BEV
} *Volume (too big!)*

Target cost x US$0.50/Wh ~Similar cost to Na-S
= US$7500 for 40 mile PHEV
= US$37,500 for 200 mile BEV
} *Cost (too expensive!)*

Lower cost, longer calendar life, higher safety, higher energy density and better temperature performance!

Acknowledge

- Ministry of Sci&Tech
- Beijing Government
- Ministry of Information and Industry
- Zhongguancun Government

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Thanks for your attention !