


BINGHAMTON UNIVERSITY
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Cathode Materials for NON-Rechargeable Batteries

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Outlines

Topics

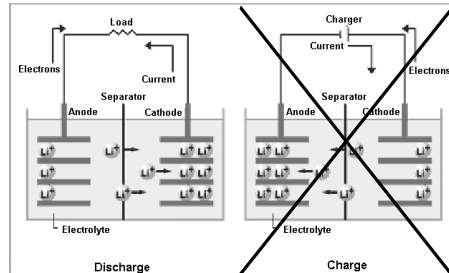
- Electrochemical cell, its cycling and parameters
- Cathode materials:
 - rechargeable (secondary)
 - vs. NON-rechargeable (primary)
- Electrochemical "phase diagrams"
- Battery materials (BAT) entries in PDF & ICSD

Important Battery Characteristics

- ✓ Voltage (average discharge)
- ✓ Capacity (by weight or volume)
- ✓ Stability (battery life)
- ✓ Kinetics (high/low)
- ✓ Environmental hazard & Safety
- ✓ Cost (\$\$)

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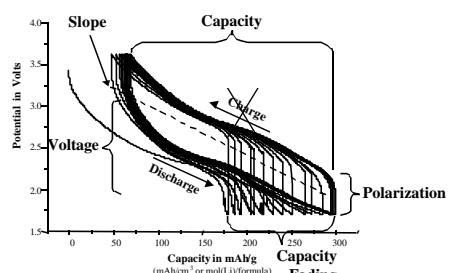
Electrochemical Cell



Cathode: Metal Oxide, Phosphate + Binder (teflon) + Conductor (carbon black)
Anode: C (graphite), Sn alloy **Electrolyte:** LiClO₄, LiPF₆, LiAsF₆,...+

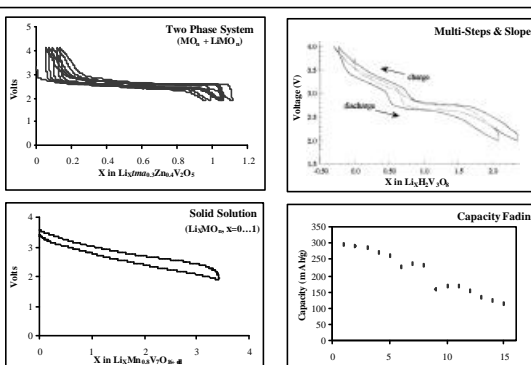
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Electrochemical Cycle & Its Parameters



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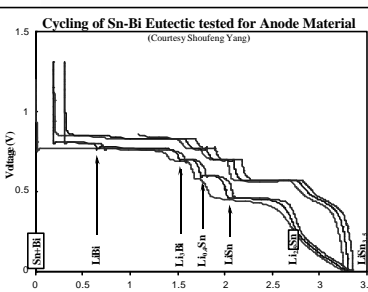
Electrochemical Cycling Behavior



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Electrochemical "Phase Diagram"

Cycling of Sn-Bi Eutectic tested for Anode Material
(Courtesy Shoufeng Yang)



	PDF#
Sn	-19-1365
Bi	-44-1246
LiBi	-27-0422
Li3Bi	-27-0427
Li30Sn	-74-0561
LBSn	-?
Li2Sn	-29-0839
Li10Sn	-29-0837

Rechargeable BAT in ICDD Database

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Cathode Material	Capacity (mAh/g)	Voltage (V)	Sp. gr.	PDF entries	ICSD entries
TiS ₂	240	2.0	<i>P3m1</i>	5	5
VSe ₂	128	2.0	<i>P3m1</i>	3	1
LiCoO ₂	274	3.7	<i>R3̄3</i>	6	13
LiMnO ₄ (Spinel)	148 280	4.0, 3.0	<i>Fd3m</i>	9	25
LiMnO ₂	286	4.0, 2.9	<i>C2/m</i>	6	11
LiFePO ₄	170	3.4	<i>Pnma</i>	1	3
LiFe ₂ (PO ₄) ₃	128	2.8	<i>P2/m</i>	1	5
β-VOPO ₄	166	3.9	<i>Pnma</i>	1	1
V ₆ O ₁₃	290	3.2, 1.8	<i>C2/m</i>	2	5
Li _{1-x} V _x O ₈	250	2.8-2.0	<i>P2/m</i>	5	11
V ₂ O ₅	270	3.5-2.0	<i>Pmmn</i>	3	3
No. of Entries				42	83
Total Entries				125	

* + 4 BAT entries marked in set 52.

NON-rechargeable BAT in ICDD Database

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NON-rech Battery	Capacity/Voltage (mAh/(g/V))	Sp. gr.	PDF entries	ICSD entries
1. Zn/MnO ₂ *	308/1.4	<i>Pnma</i>	3	3
2. Li/MnO ₂ *	308/3.0			
3. Li/Ag ₂ V ₂ O ₇ (SVO or CSVO)	315/3.2	<i>C2/m</i>	2	1
4. Li/I ₂		<i>Cmca</i>	2	(16) [§]
5. Li/SOCl ₂		<i>P2/c</i>	0	1
6. Li/CF ₃	33.3-3.5		2	0
7. Zn/AgO		<i>P2/c</i>	1 ^{CALC}	3
8. LiTi ₂ (PO ₄) ₃ [LTP]			1	0
9. Li/V ₂ O ₅		<i>Pmmn</i>	(3)	(3)
10. Li/NbO ₂			(16) [*]	(6) [§]
11. Zn/HgO ^{**}			1	(8) [§]
12. Mg/MnO ₂			same as in 1,2	
13. Li/CuO		<i>C2/c</i>	1	7
14. Li/FeS ₂		<i>Pa3̄</i>	1	2
15. Li/CuFeS ₂		<i>Pa3̄</i>	2	3
No. of Entries			17	21
Total Entries			38	

* Ramsdellite (or R-MnO₂); ** now-discontinued "Mallory cells"; § several modifications

What is next?

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Properties to include for NON-rechargeable BM:

- Voltage (V)
- Capacity (mAh/g, mAh/cm³, mol/unit)
- ~~Cyclability (no. of cycles)~~

NEXT:

- > anode materials;
- > electrochemical phase diagrams;
- > new cathode materials;
- > other related compounds?