Performance and Safety Evaluation of Intec Li-ion Cells

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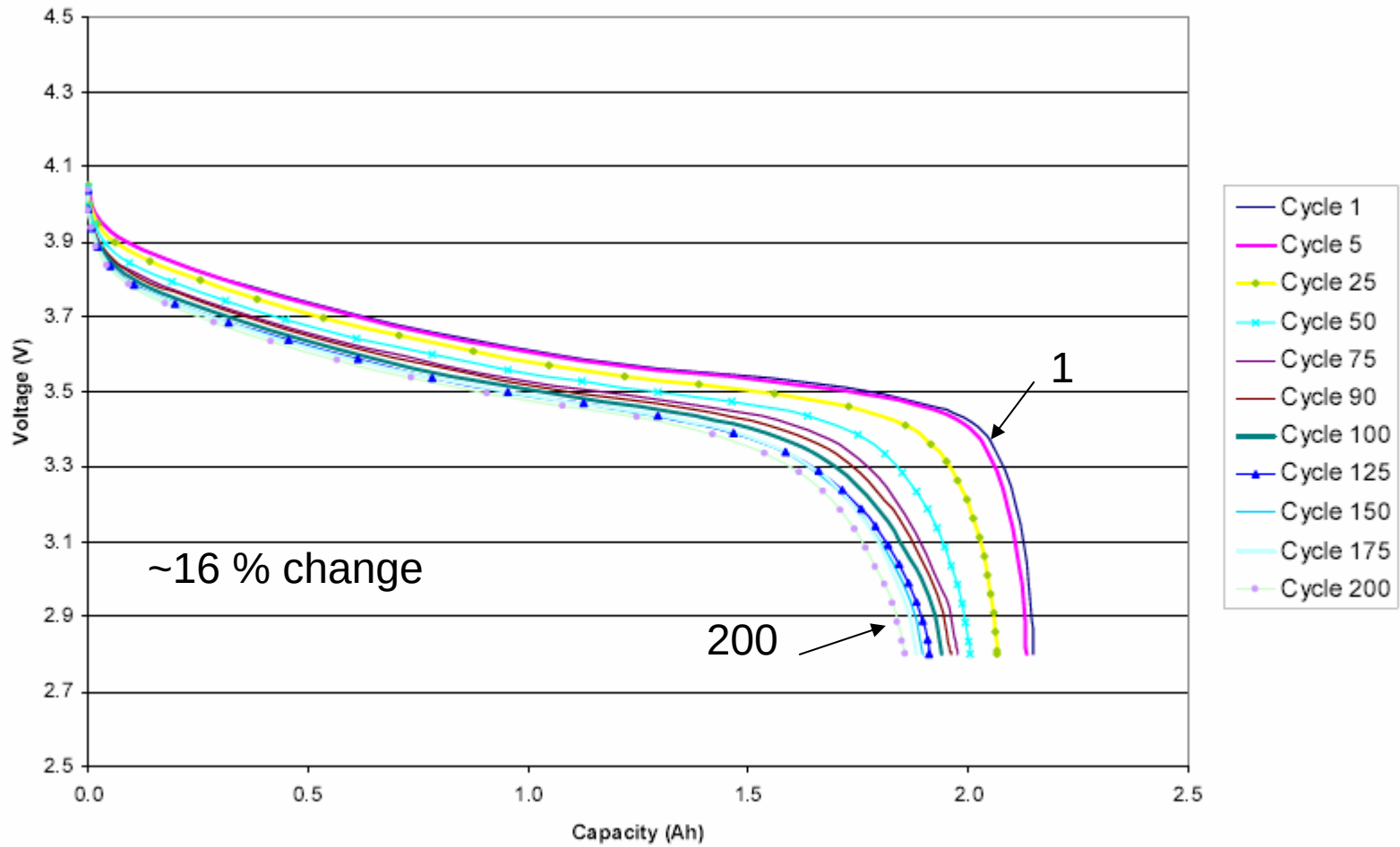
The 2006 NASA Battery Workshop
Huntsville, AL
November, 2006

Introduction

- Cells purchased as part of the R&D on SOTA li-ion cells
- 2 Ah capacity

Rate Capability Test
1C Rate of Charge and Discharge



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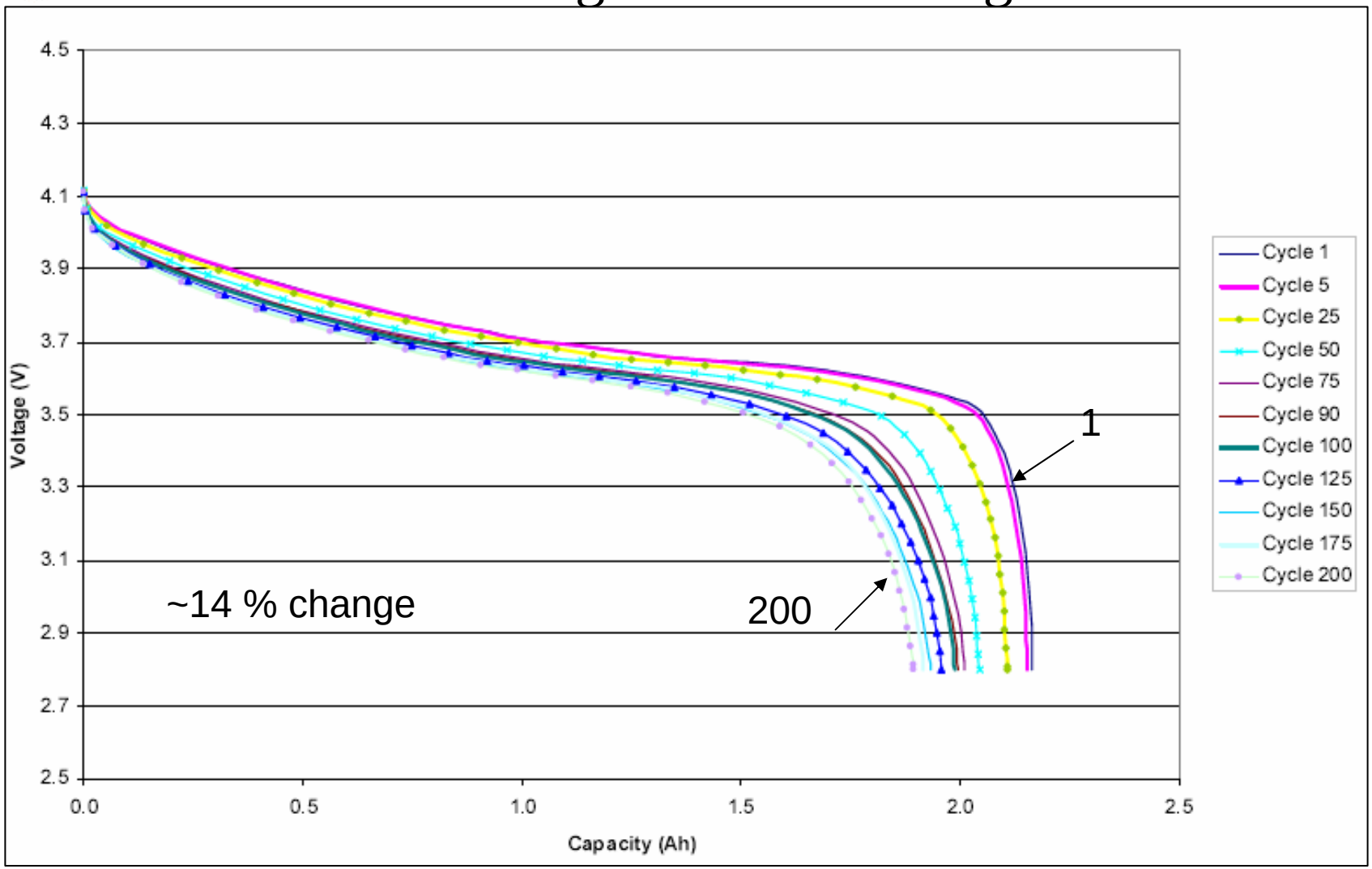
Rate Capability of Intec Li-ion Cells
1C Charge/0.5 C Discharge



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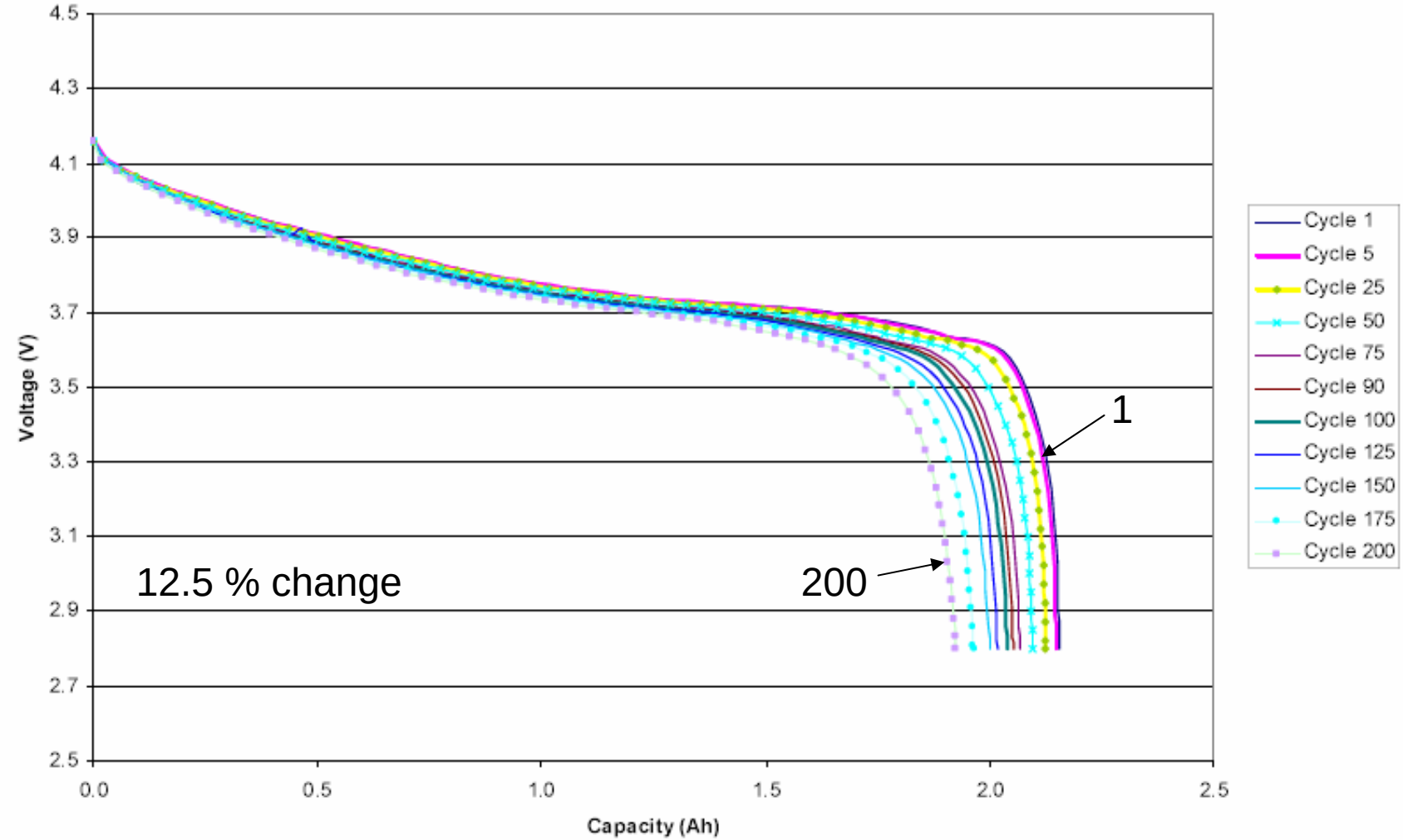
Rate Capability of Intec Li-ion Cells
1C Charge/0.2C Discharge



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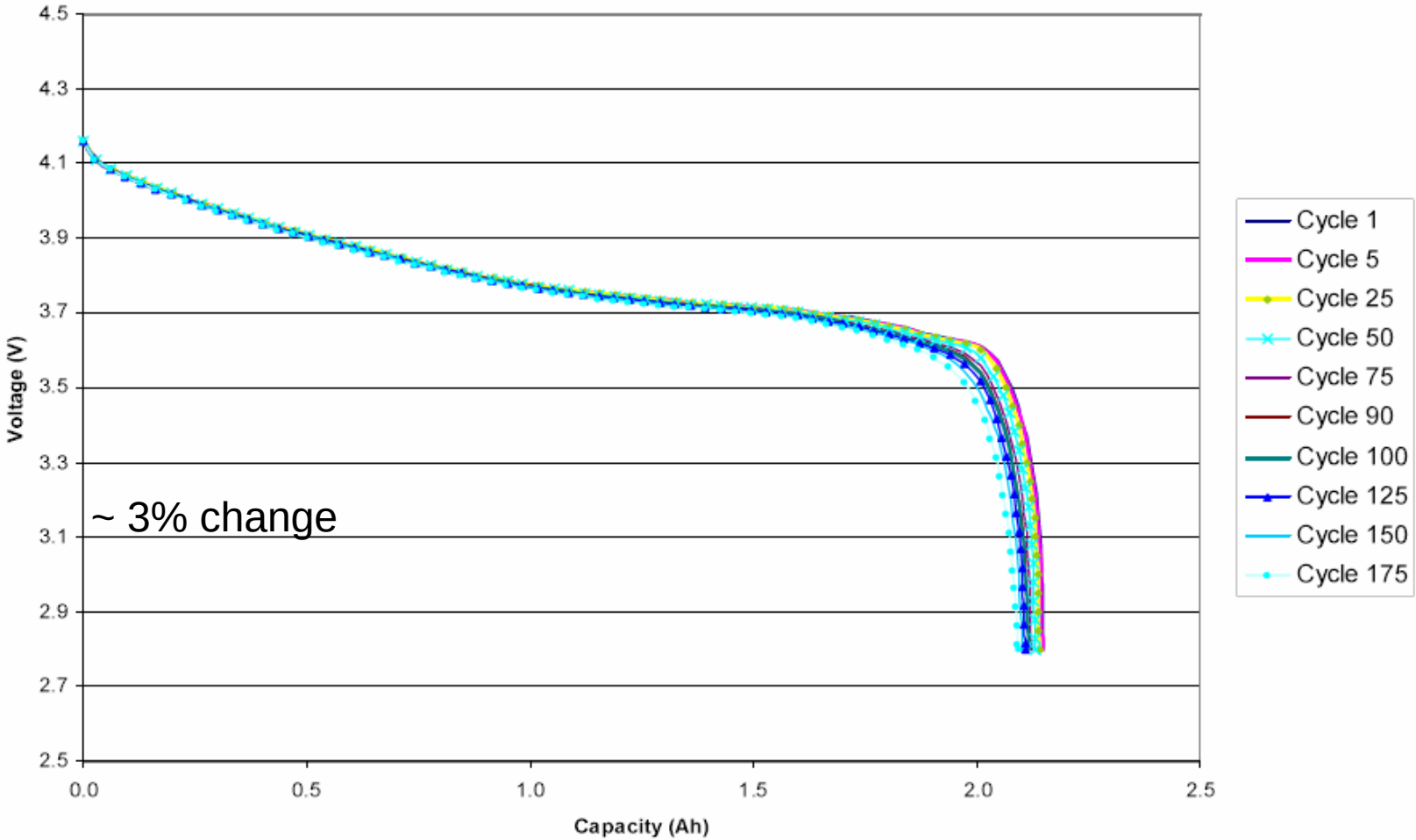
Rate Capability Test on Intec Li-ion Cells
0.2 C Charge and Discharge



Other Protocols:

0.5 C Charge/1C, 0.5 C or 0.2 C Disch

0.2 C Charge / 1 C, 0.5 C Disch

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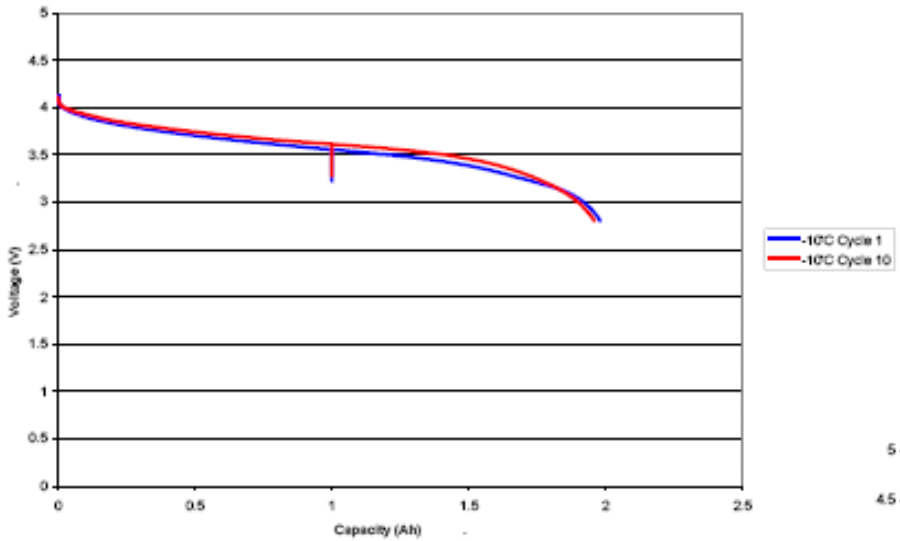
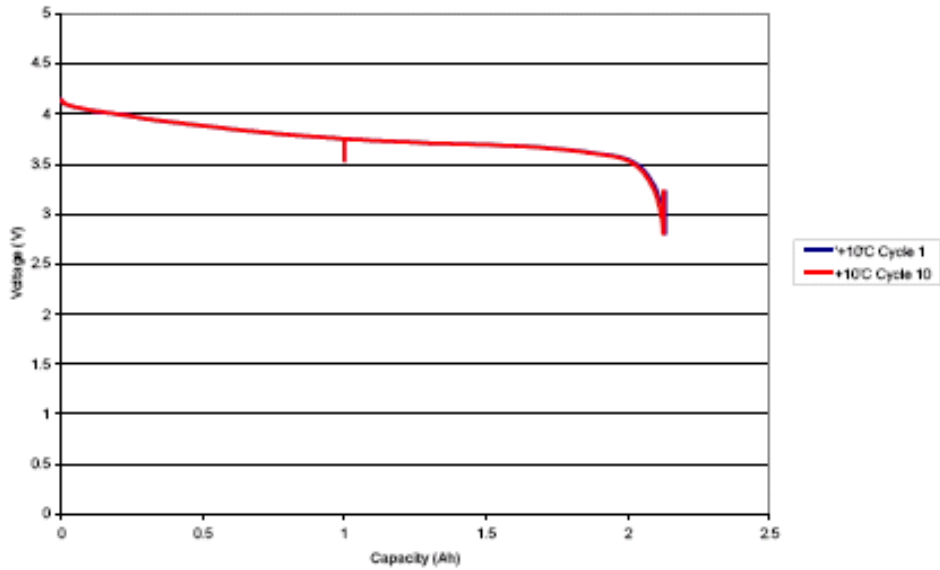
Performance of Intec Li-ion cells at Different Temperatures



Temp: -10 ºC

Temp: 10 ºC



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Performance of Intec Li-ion Cells at Different Temperatures

C/D: C/5 rate at given temp

Cycle #	Temp -10°C		Temp 10°C		Temp 25°C		Temp 40°C	
	Cell 19	Cell 20	Cell 23	Cell 22	Cell 29	Cell 24	Cell 25	Cell 26
1	1.980	1.991	2.144	2.133	2.167	2.165	2.186	2.170
2	1.985	1.996	2.142	2.134	2.165	2.164	2.184	2.169
3	1.987	1.999	2.140	2.132	2.164	2.163	2.183	2.168
4	1.990	2.004	2.139	2.130	2.163	2.161	2.182	2.167
5	1.993	2.007	2.139	2.128	2.162	2.161	2.181	2.166
6	1.980	1.994	2.138	2.127	2.161	2.160	2.180	2.165
7	1.977	1.990	2.136	2.127	2.160	2.159	2.180	2.165
8	1.972	1.985	2.136	2.126	2.160	2.158	2.179	2.164
9	1.967	1.979	2.136	2.125	2.159	2.158	2.178	2.163
10	1.959	1.970	2.135	2.124	2.158	2.157	2.178	2.163
	1 %		0.4 %		0.4 %		0.36 %	

Effective Internal Resistance at Different Temperatures

Cycle #	Temp -10°C		Temp 10'C		Temp 25°C		Temp 40°C	
	Cell 19	Cell 20	Cell 23	Cell 22	Cell 29	Cell 24	Cell 25	Cell 26
1	0.1242	0.1281	0.0800	0.0811	0.0689	0.0710	0.0653	0.0671
2	0.1233	0.1272	0.0804	0.0806	0.0689	0.0711	0.0654	0.0673
3	0.1215	0.1250	0.0809	0.0810	0.0689	0.0710	0.0655	0.0673
4	0.1204	0.1240	0.0812	0.0816	0.0690	0.0710	0.0655	0.0673
5	0.1187	0.1223	0.0807	0.0819	0.0690	0.0710	0.0655	0.0674
6	0.1218	0.1255	0.0810	0.0821	0.0691	0.0711	0.0657	0.0676
7	0.1214	0.1253	0.0812	0.0818	0.0691	0.0711	0.0655	0.0676
8	0.1224	0.1261	0.0813	0.0818	0.0692	0.0711	0.0658	0.0677
9	0.1230	0.1268	0.0810	0.0821	0.0692	0.0713	0.0659	0.0678
10	0.1241	0.1288	0.0810	0.0820	0.0692	0.0713	0.0659	0.0680

Discharge: C/5 Pulse: 1.5 C for 100 ms

Performance of Intec Li-ion Cells at -30 °C

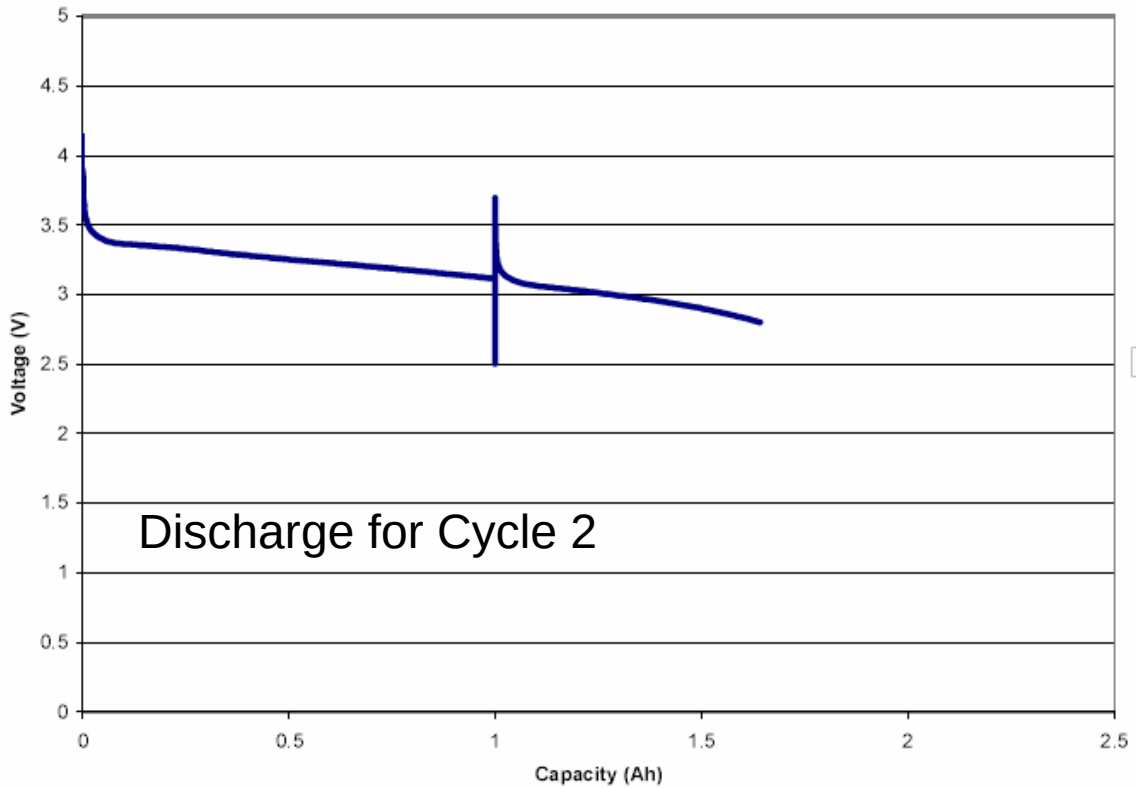
Capacity:

Cycle #	Temp	-30ºC
	Cell 24	Cell 29
1	*1.000*	*1.000*
2	1.618	1.641

R_e:

Cycle #	Temp	-30ºC
	Cell 24	Cell 29
1	0.2516	0.2429
2	0.2383	0.2296

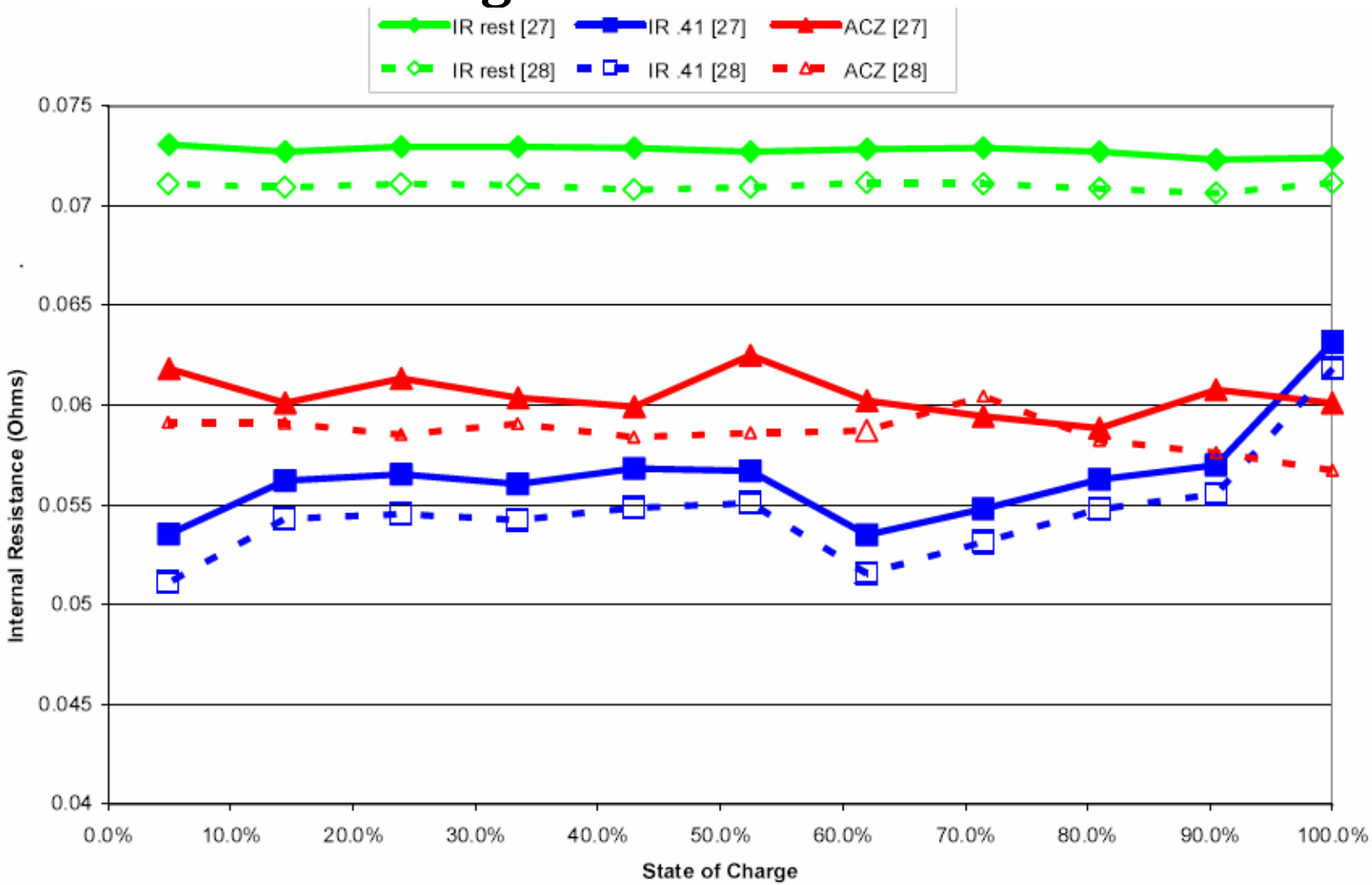
C/D: C/5 rate;
Charge at room temperature
Discharge at -30 ºC



Summary of Intec Li-ion Cell Performance at Different Temperatures

Temperature	Capacity (Ah)	Effective Internal Resistance (Ohms)
40°C	2.174	.0667
25°C	2.161	.0701
10°C	2.133	.0812
-10°C	1.980	.1240
-30°C	1.630	.2406
Internal Resistance is relatively independent of state-of-charge.		

Effective Internal Resistance versus State-of-Charge for Intec Li-ion Cells



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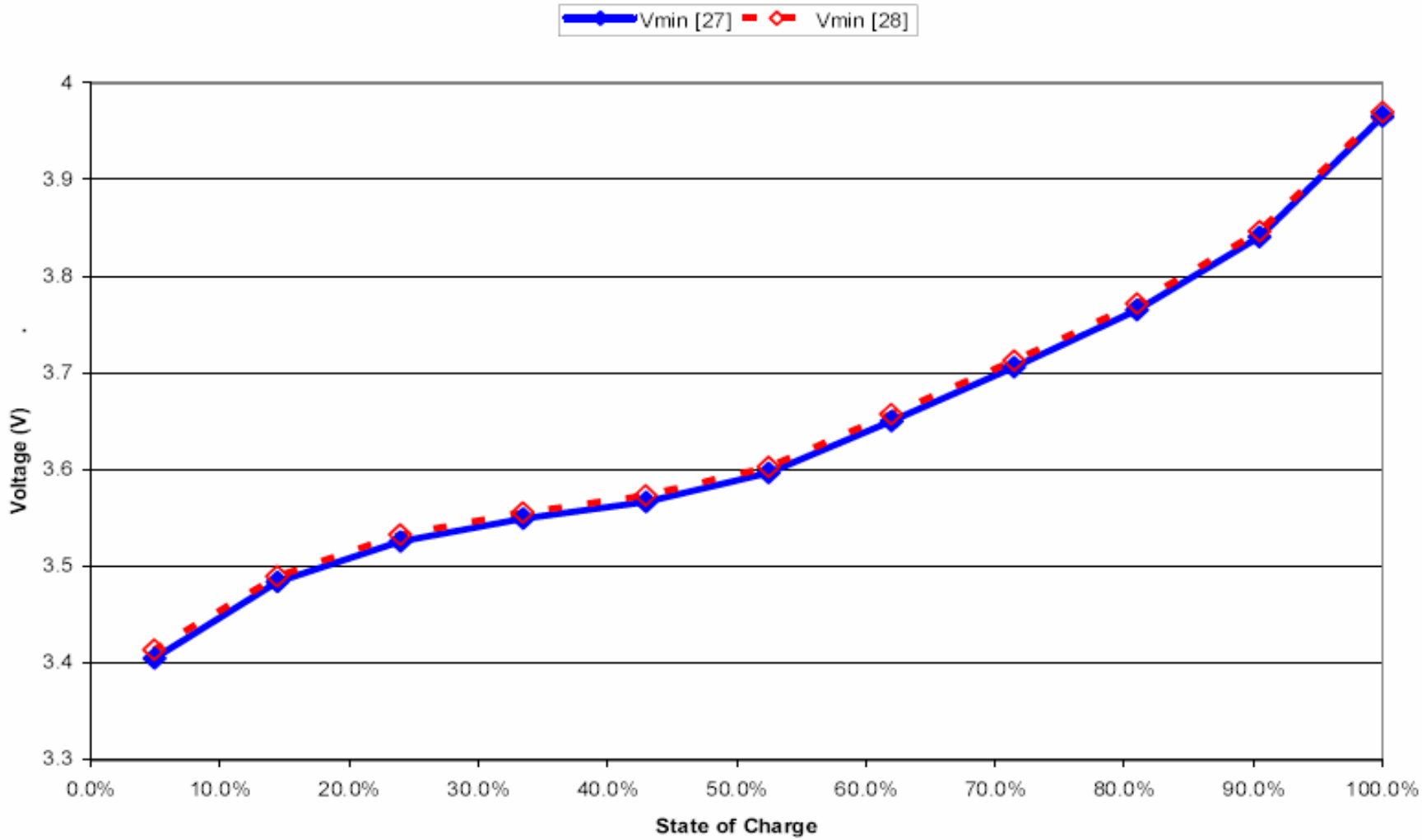
End-of-Pulse Voltage versus State-of-Charge



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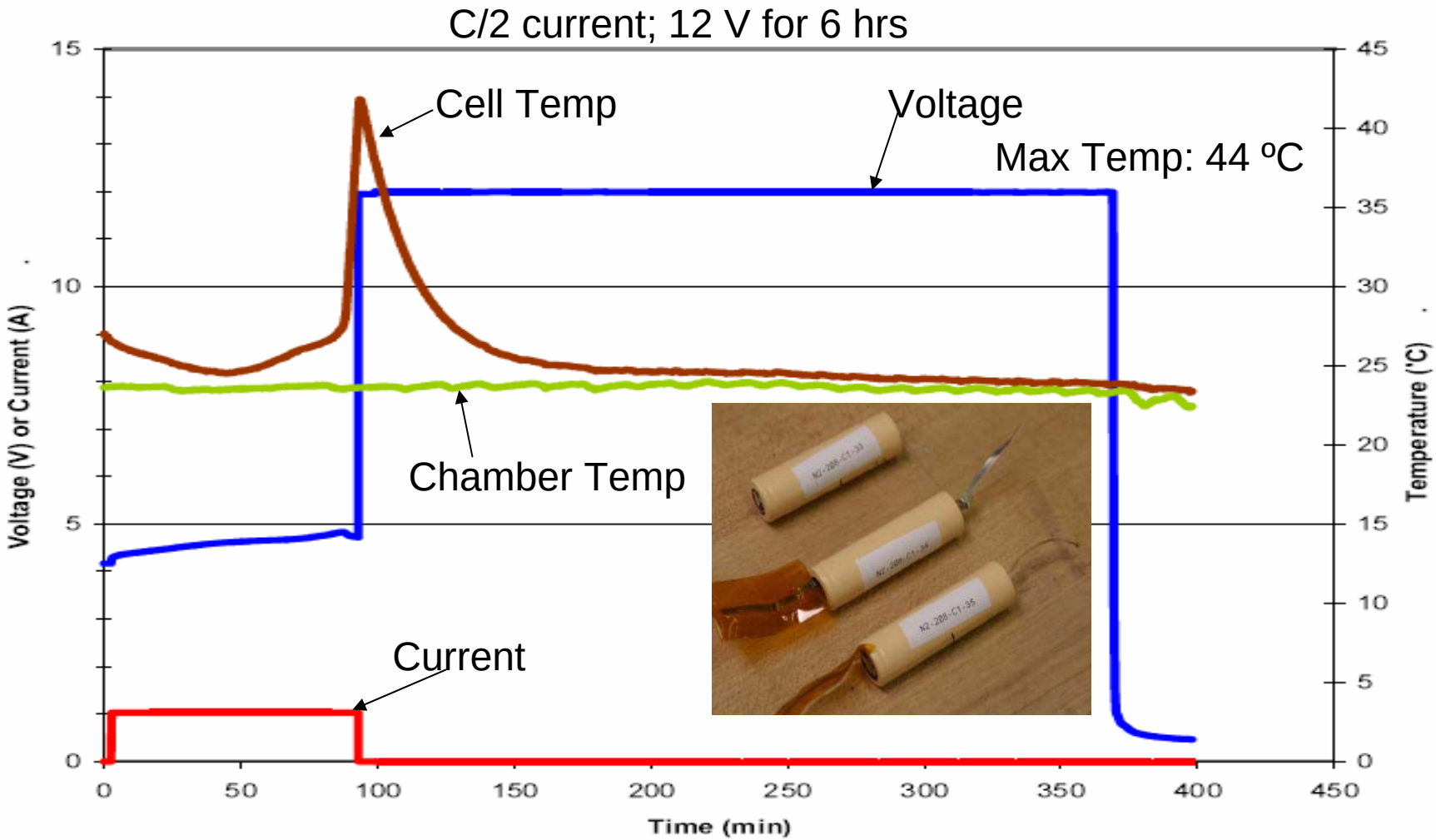
Vent and Burst Pressure Test

Cell #	Seq. #	OCV	Test	Vent Pressure	Burst Pressure
				psig	psig
N2-208-B2-21	1	0.00	Vent Test	210	
N2-208-B4-30	2	3.45	Vent Test	190	
N2-208-B4-31	3	3.47	Burst Test		850
N2-208-B4-32	4	3.45	Burst Test		865

At approx 600 psig, some gas leakage was observed near the crimp during the burst test

Overcharge Test on Intec Li-ion Cell



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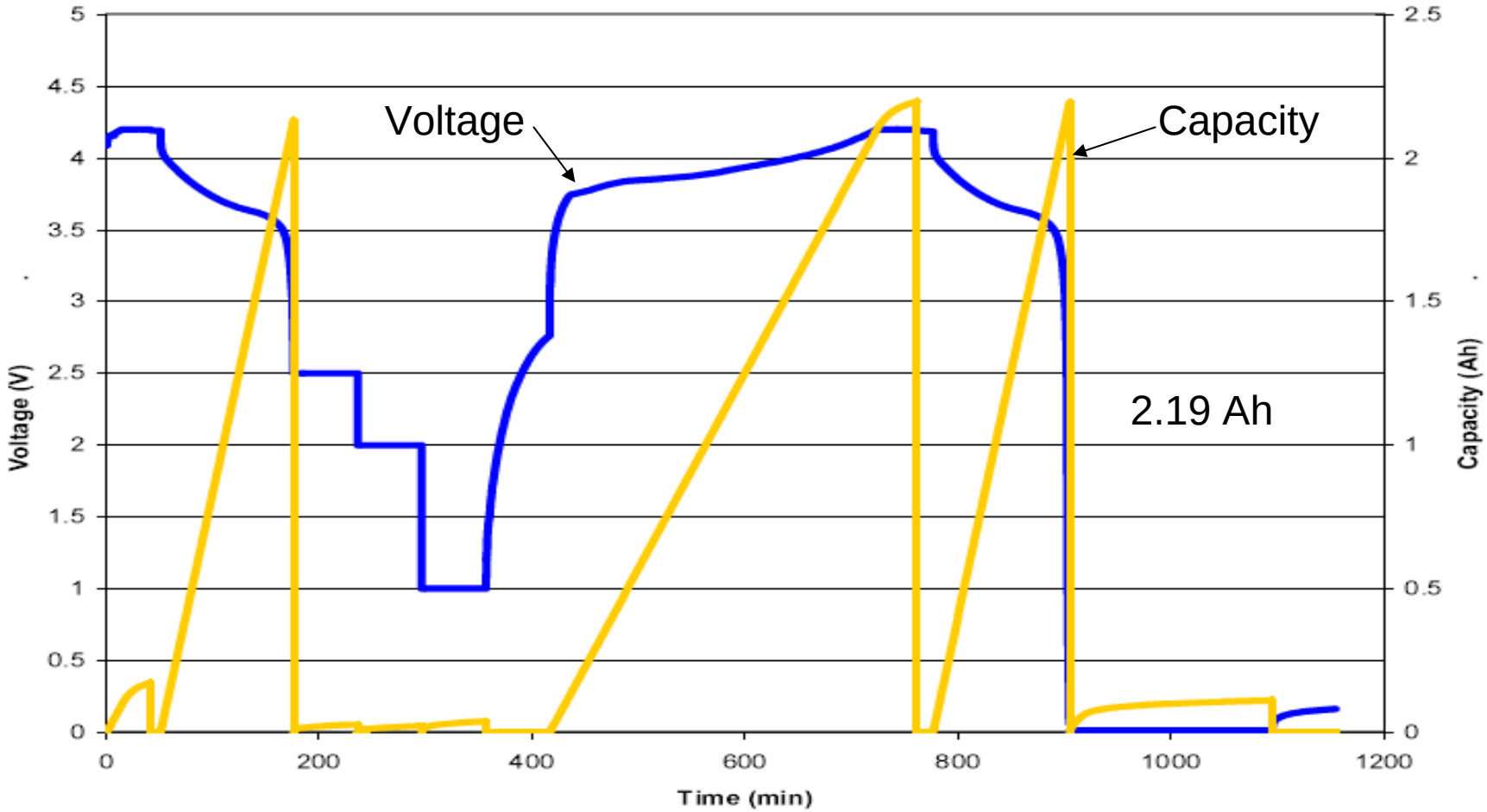
Overdischarge Test of Intec Li-ion Cell

C/2 current to 0 V



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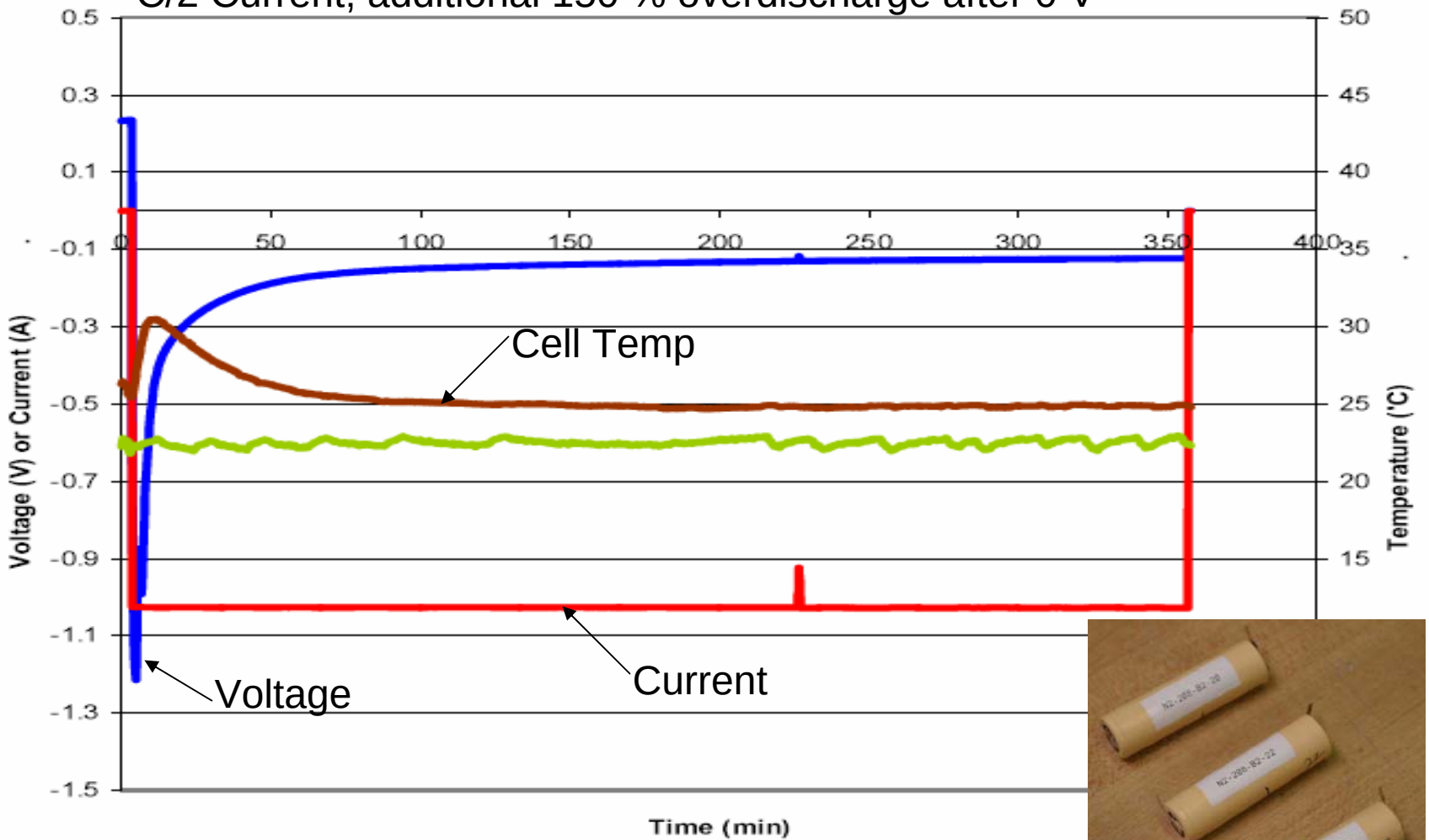
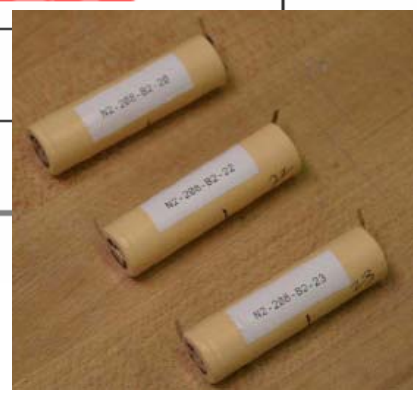
Overdischarge into Reversal Test of Intec Li-ion Cells

C/2 Current; additional 150 % overdischarge after 0 V





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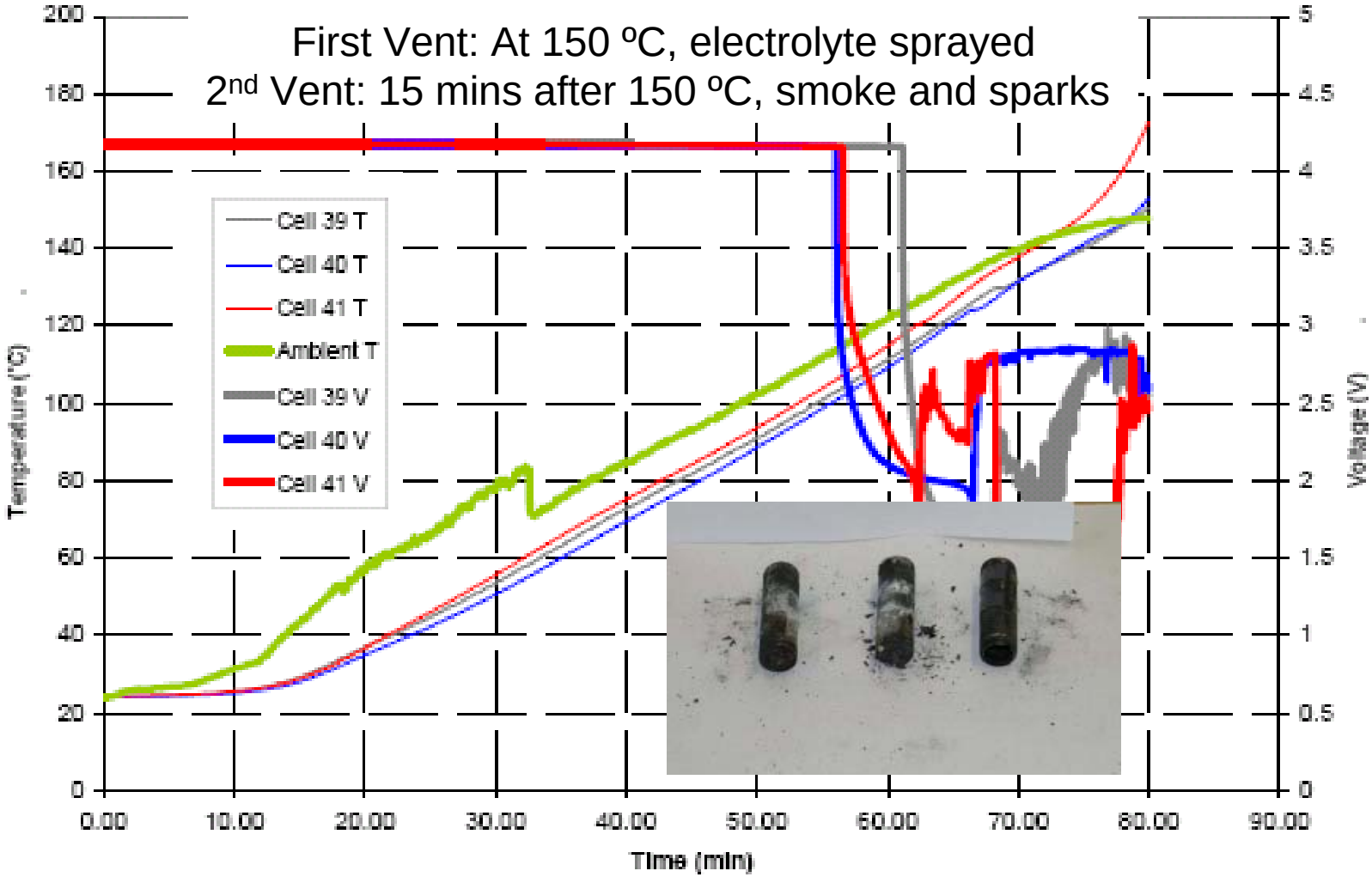
High-Temperature Exposure and Heat-to-Vent for Intec Li-ion Cells



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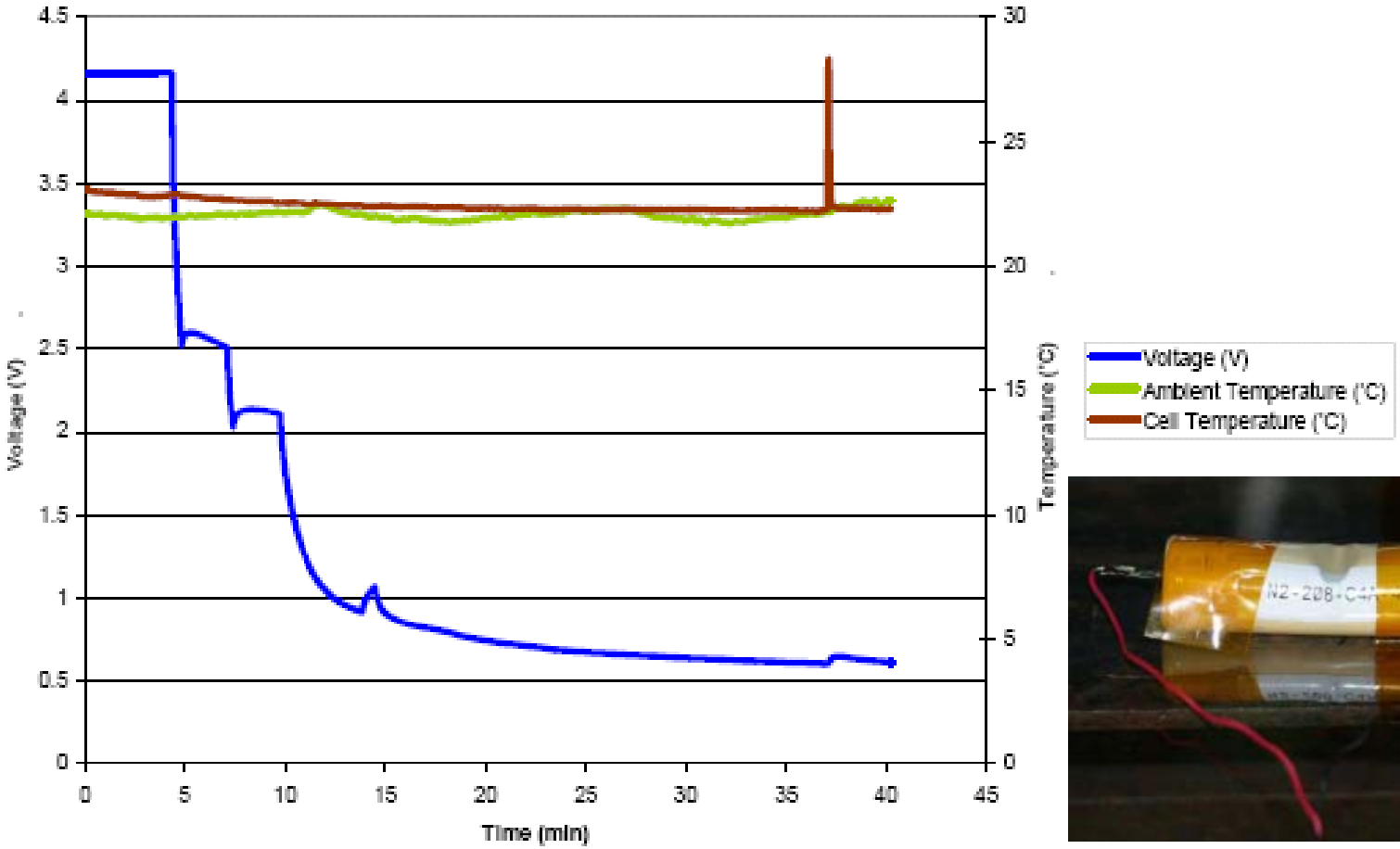
Simulated Internal Short (Crush) Test on Intec Li-ion Cells



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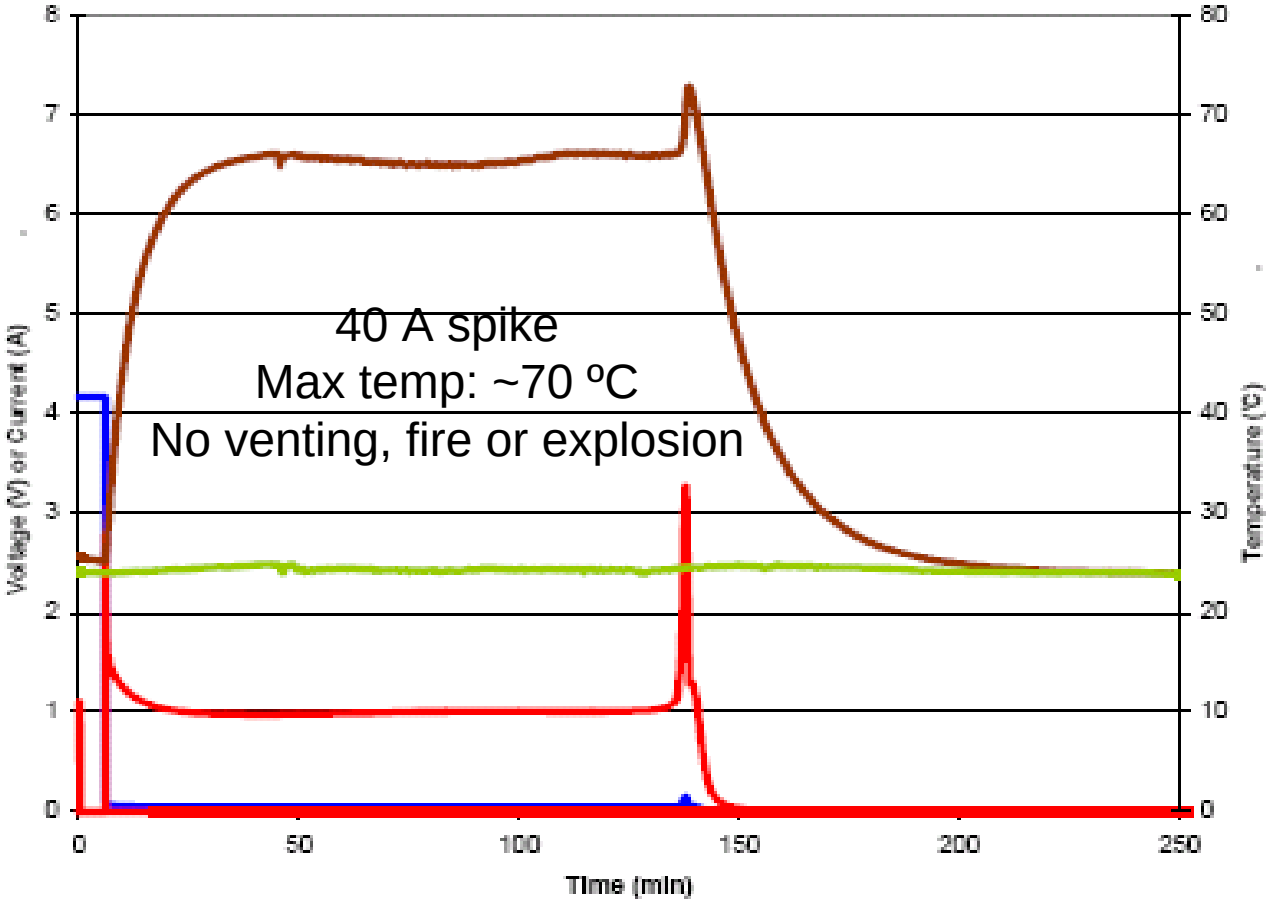
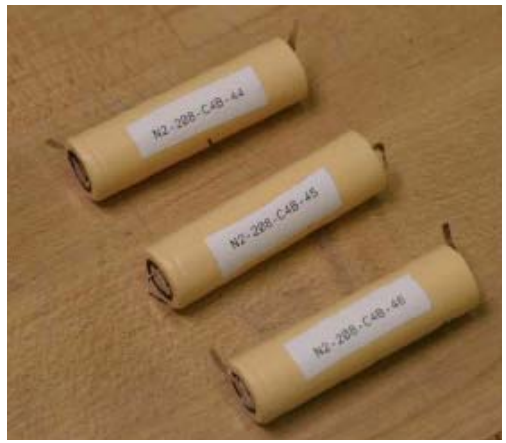
External Short Circuit Test on Intec Li-ion Cells

Load : 50 mohm





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Summary and Conclusions

- **Cell performance is best at C/5 rate of charge and discharge and worst at 1C rates**
- **Cell performance is good at the different temperatures even at low temperatures**
  - 50 % capacity obtained at -30 ^{o}C
- **Overcharge causes the opening of the CID**
- **Overdischarge is benign**
- **External short circuit is benign**
- **Simulated internal short is also benign**
- **Cell does not tolerate temperatures at or above 150 ^{o}C. Electrolyte spewing, smoke and sparks observed during venting.**

Acknowledgment

Mobile Power Solutions