Technical presentation of 15L

15L(15Q NMC) vs. 15Q NCA

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Energy Business Division
SAMSUNG SDI

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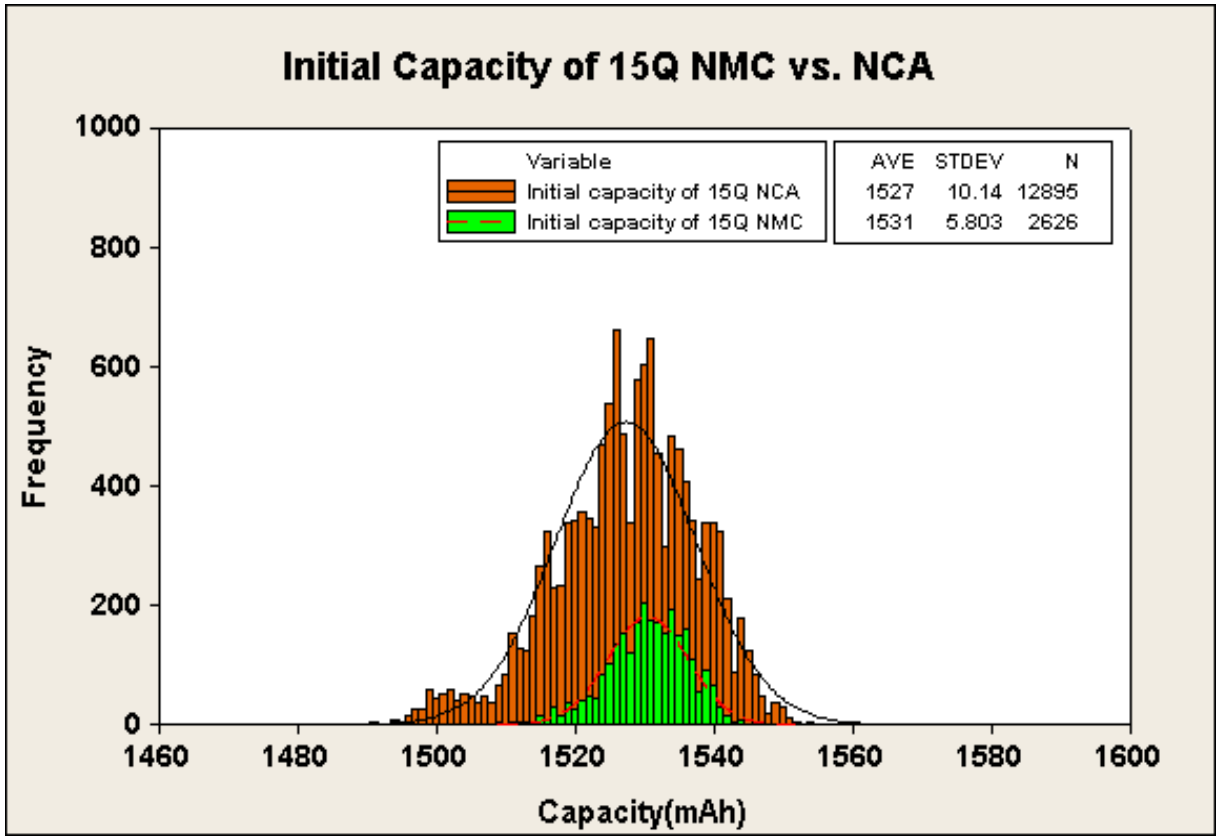
Specification summary of 15L (15Q NMC)

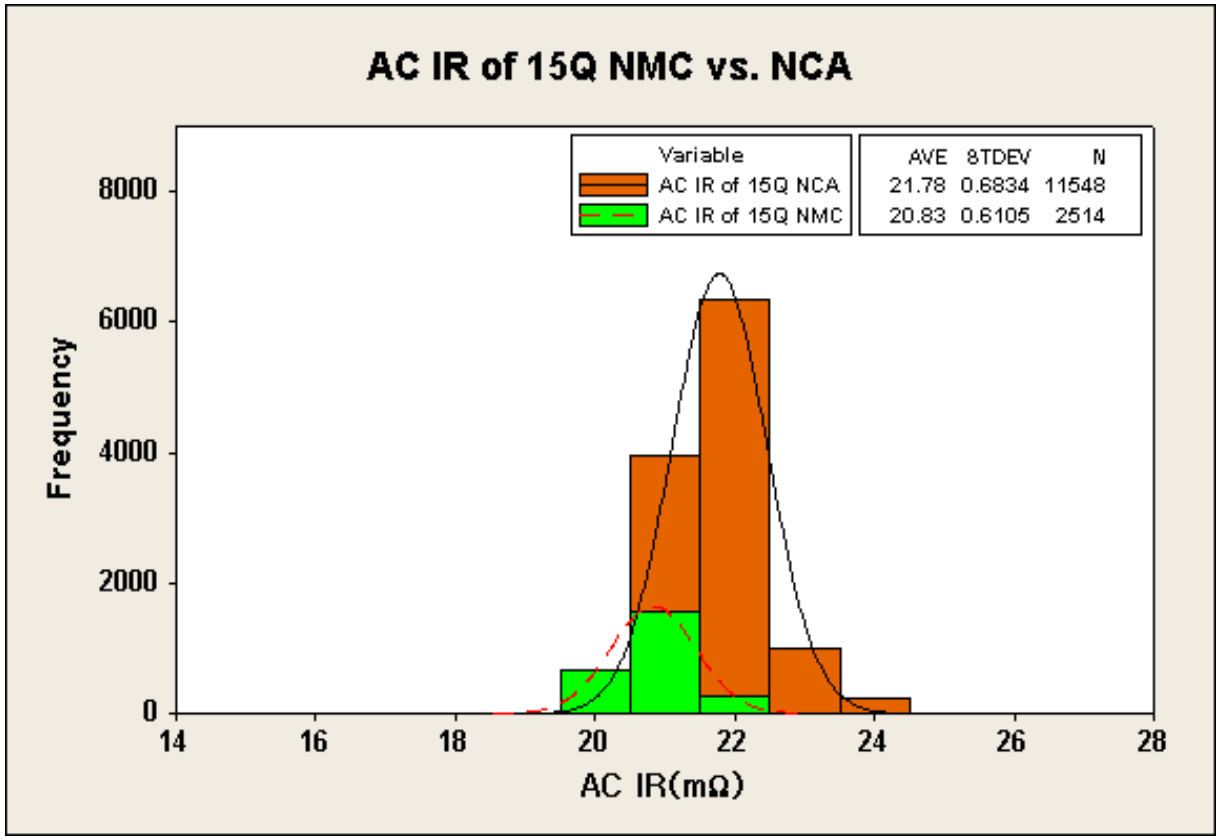
Type		Spec.	NMC based 15L	NCA based 15Q(Ref.)
Chemistry		-	NMC / LMO	NCA / LMO
Dimension (mm)	Diameter	Max. 18.25	18.15 ± 0.1	18.15 ± 0.1
	Height	Max. 65.0	64.85 ± 0.15	64.60 ± 0.15
Weight		Max. 45.0	42	42
Initial IR (mΩ AC 1kHz)		≤ 30	21 ± 2	22 ± 2
Initial IR (mΩ DC (10A-1A))		≤ 45	31 ± 2	34 ± 2
Nominal Voltage (V)		3.6	3.68	3.68
Charge Method (100mA cut-off)		CC-CV (4.2± 0.05V)	CC-CV (4.2± 0.05V)	CC-CV (4.2± 0.05V)
Charge Time	Standard (min), 0.5C	150	130	130
	Rapid (min), 4A	40	38	38
Charge Current	Standard current (A)	0.75	0.75	0.75
	Max. current (A)	4	4	4
Discharge	End voltage (V)	2.5	2.5	2.5
	Max. current (A)	18	18	18
Rated discharge Capacity	Standard (Ah) (0.2C)	1.50	1.55	1.55
	rated (Ah) (10A)	1.45	1.53	1.53

Initial discharge capacity of NMC vs. NCA



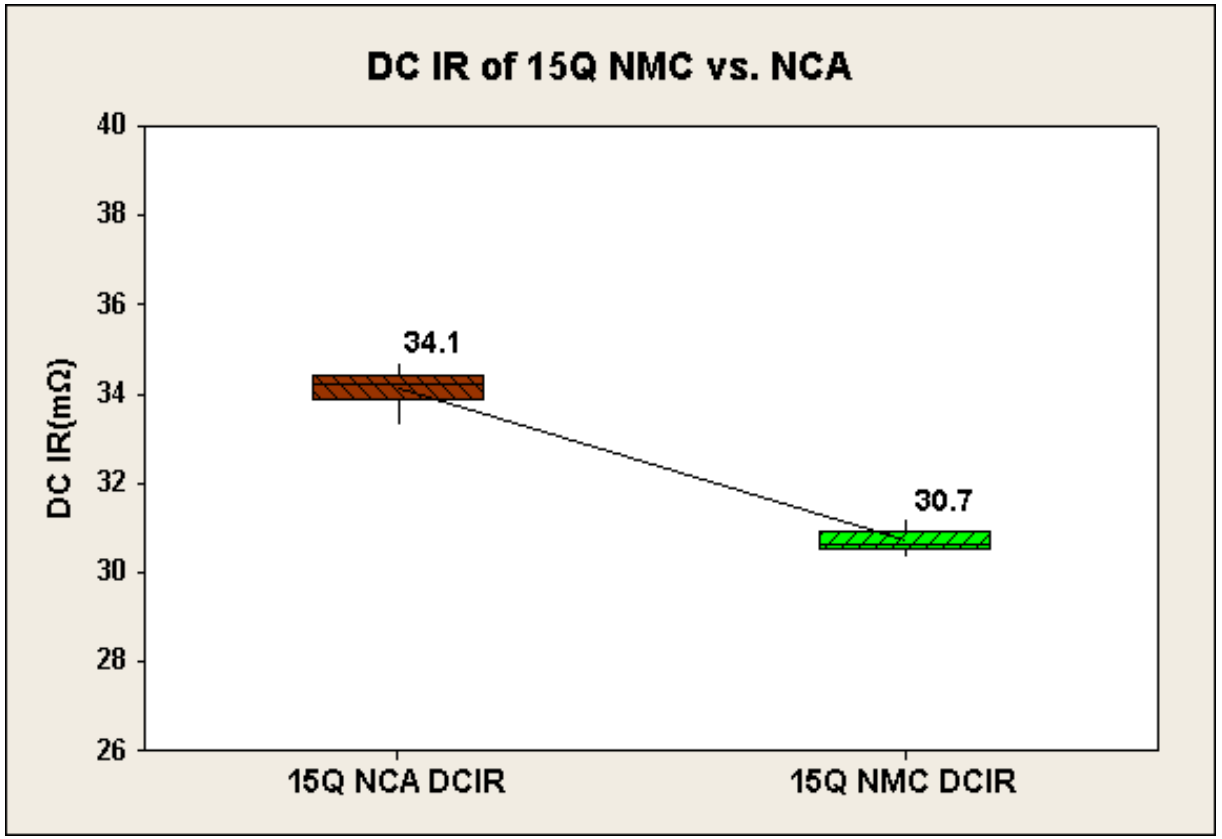
- 15L(15Q NMC) : Ave. 1531 ± 30mAh
- ref. 15Q NCA : Ave. 1527± 30mAh

AC impedance of NMC vs. NCA



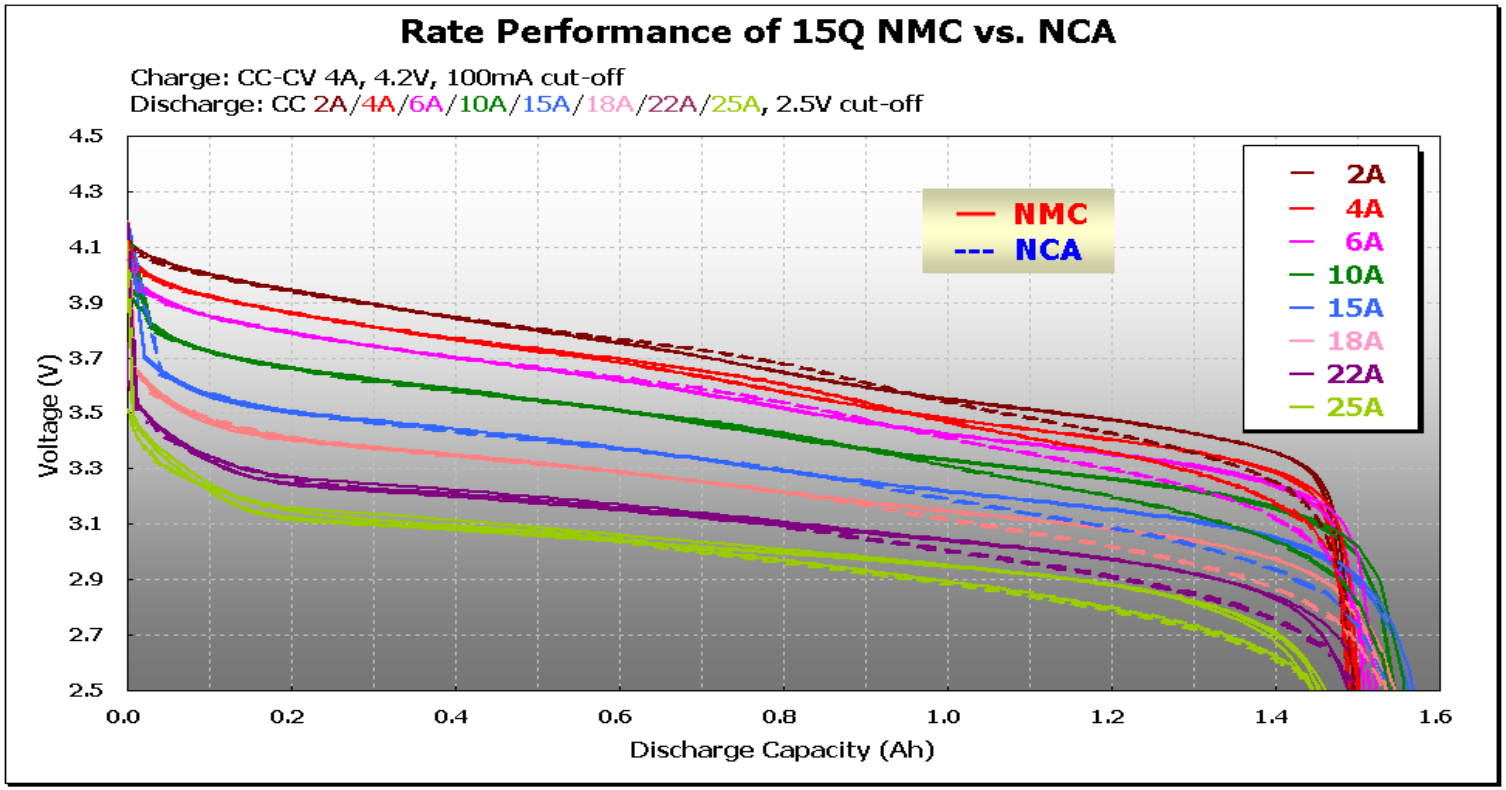
- 15Q NMC : Ave. 20.8 ± 2.0mΩ
- Ref. 15Q NCA : Ave. 21.8 ± 2.0mΩ

DC impedance of NMC vs. NCA



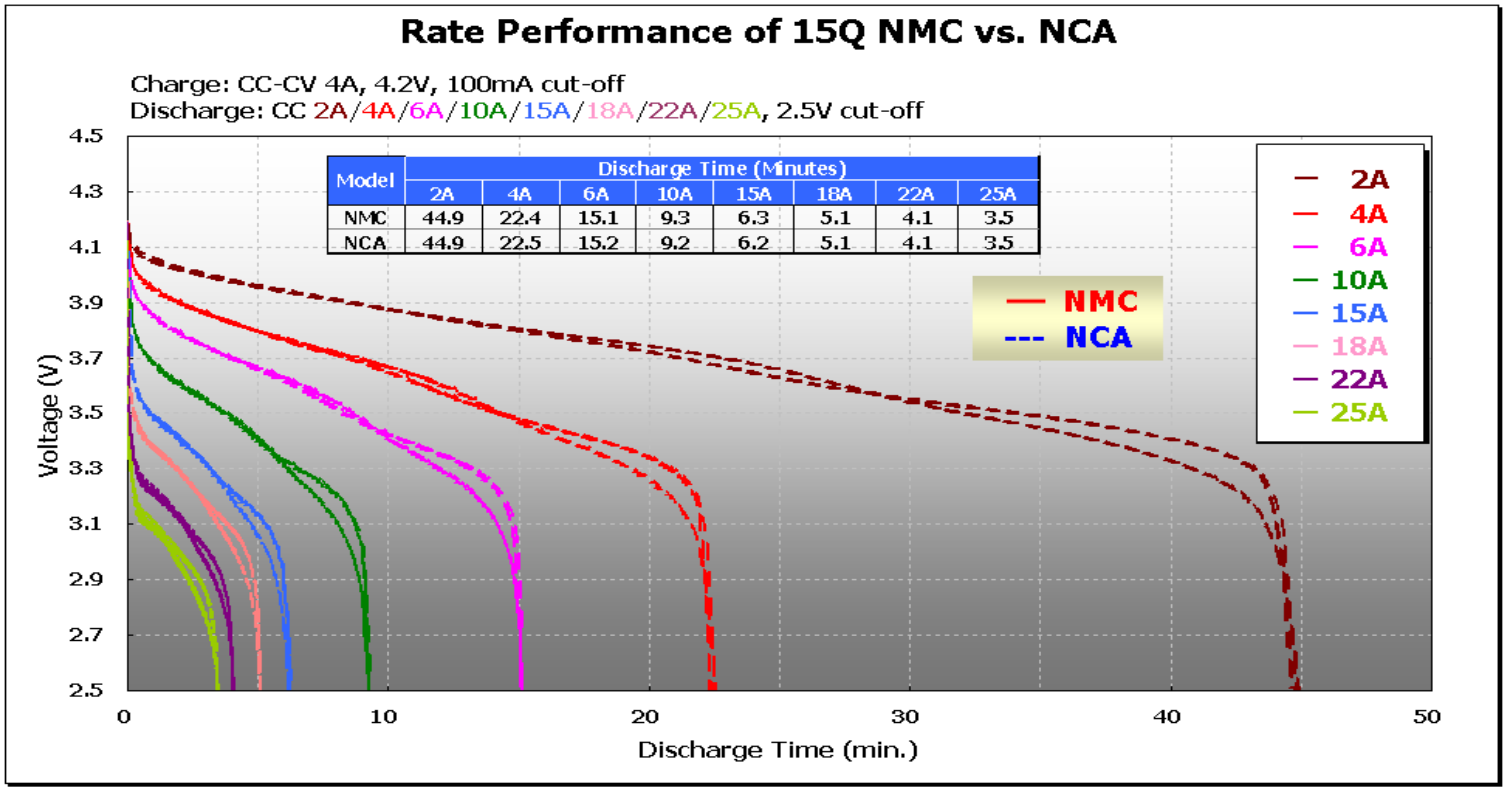
- 15Q NMC : Ave. 30.7 ± 2.0mΩ
- Ref. 15Q NCA : Ave. 34.1 ± 2.0mΩ

Rate capability of NMC vs. NCA (capacity)



Current(A)	NMC-Capa.(Ah)	NCA-Capa.(Ah)	NMC-Energy(Wh)	NCA-Energy(Ah)	% of Cap.(vs. NCA)	% of Ener.(vs. NCA)
2A	1.531	1.508	5.49	5.47	101.5%	100.4%
4A	1.494	1.501	5.38	5.38	99.6%	100.1%
6A	1.513	1.515	5.35	5.32	99.8%	100.5%
10A	1.549	1.540	5.30	5.23	100.6%	101.4%
15A	1.564	1.540	5.15	5.03	101.6%	102.3%
18A	1.538	1.530	4.95	4.89	100.5%	101.3%
23A	1.494	1.501	4.64	4.62	99.5%	100.4%
25A	1.453	1.451	4.37	4.32	100.1%	101.2%

Rate capability of NMC vs. NCA (time)



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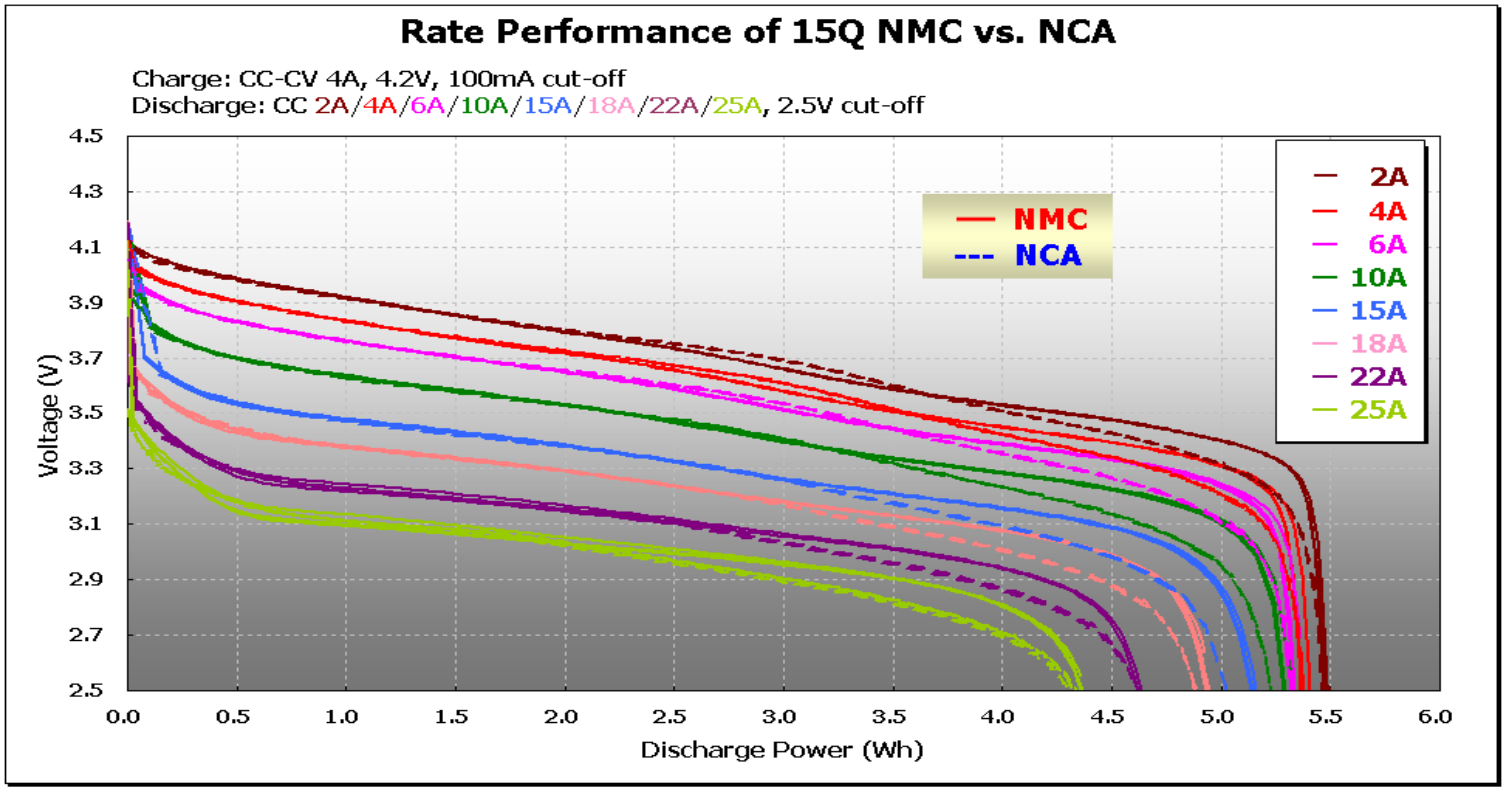
Rate capability of NMC vs. NCA (energy)



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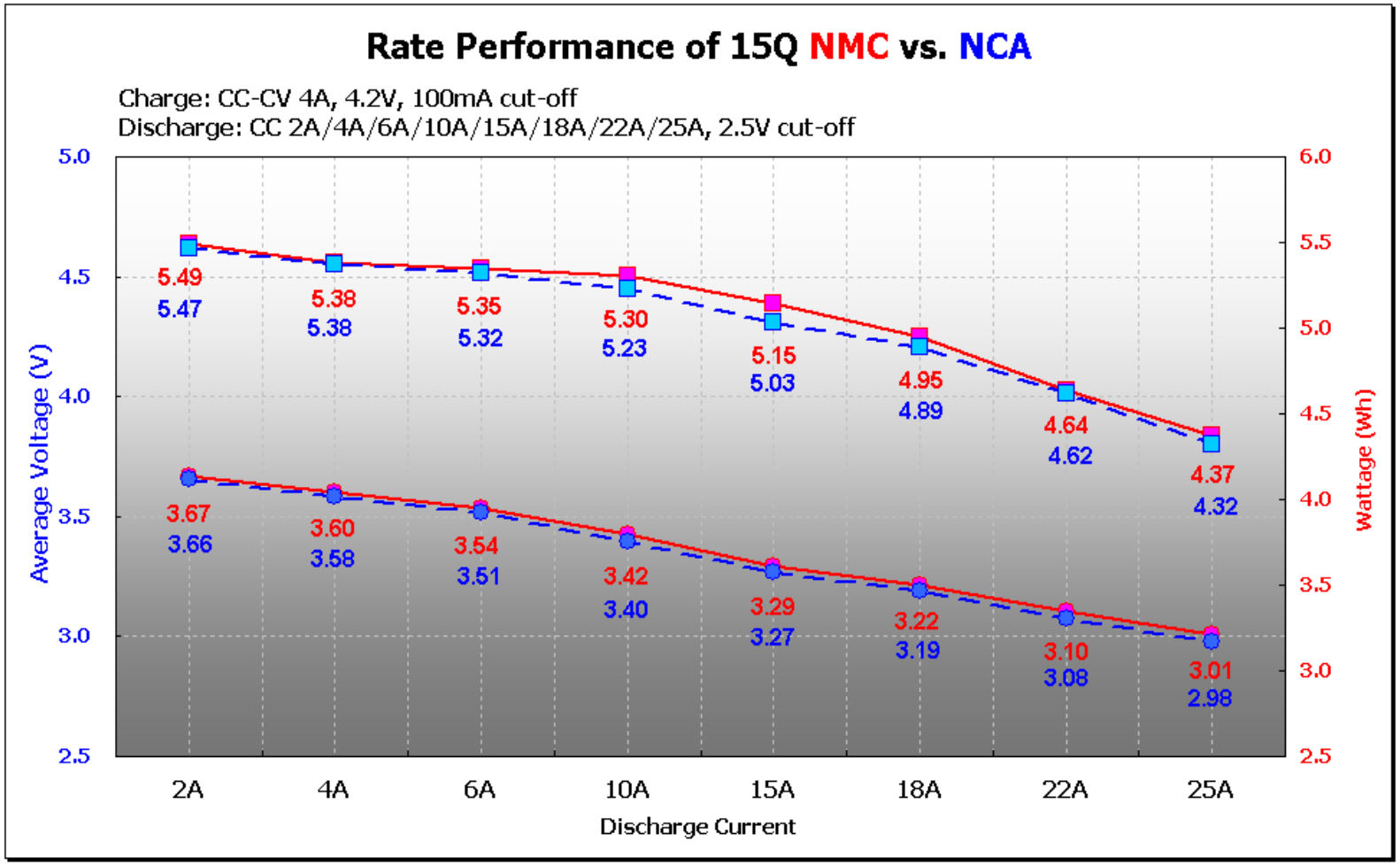
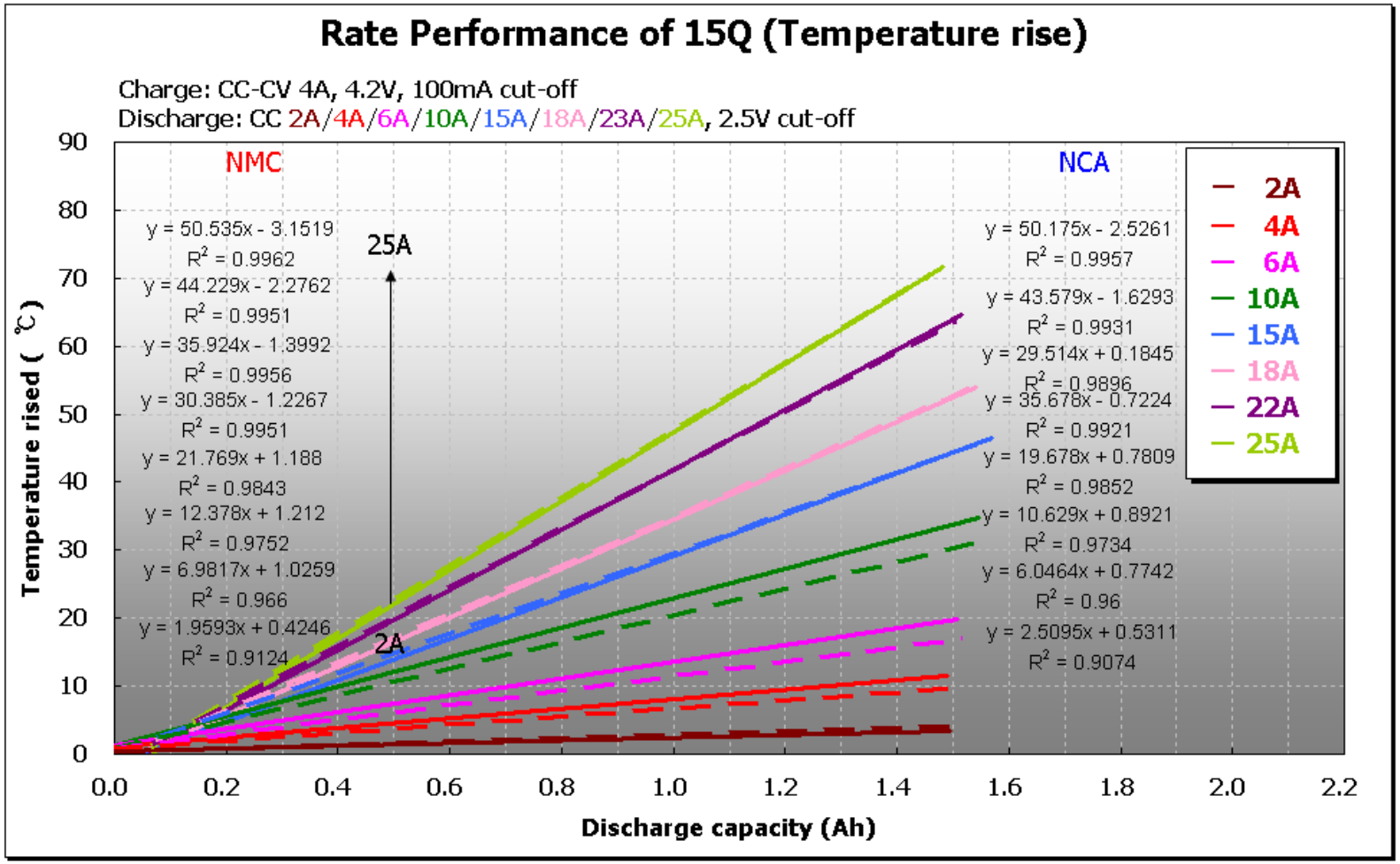
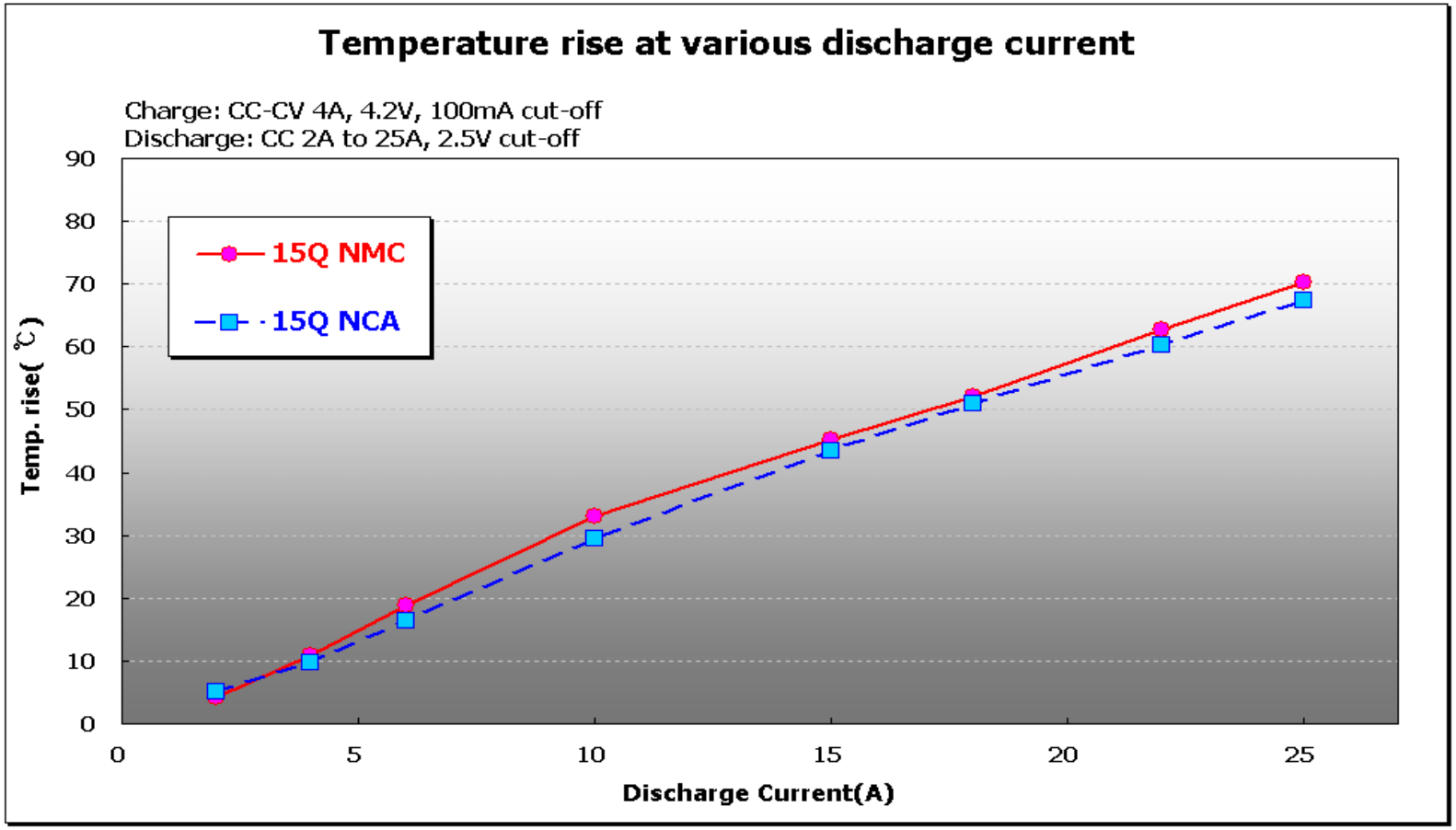
Rate capability of NMC (energy & voltage)



Rate capability of NMC (temperature rise)

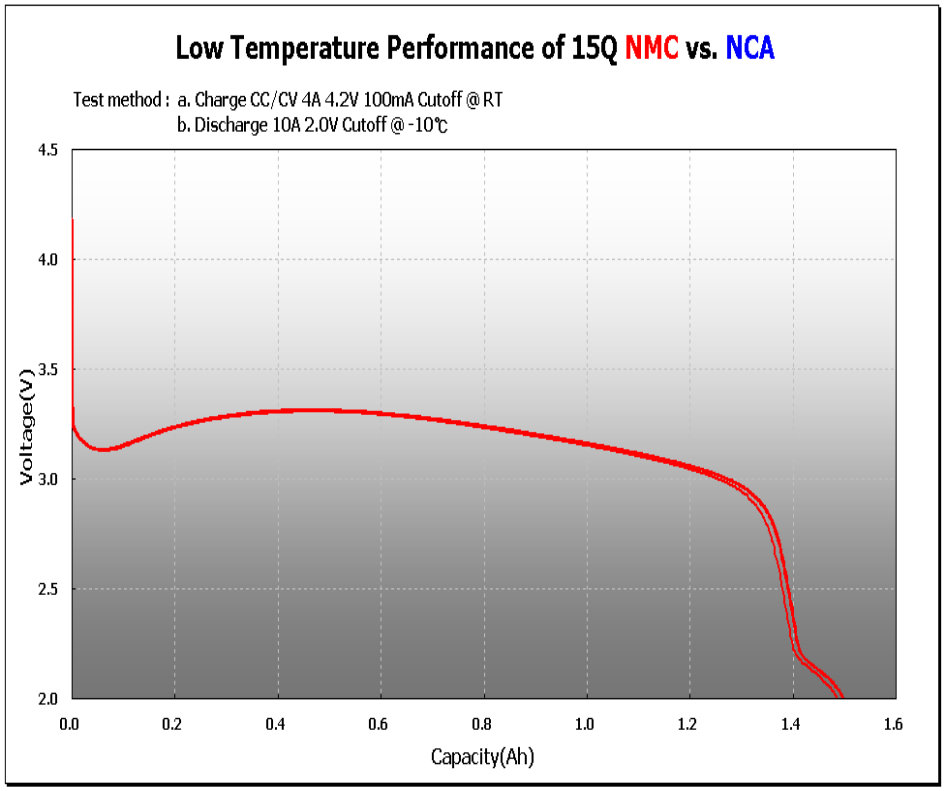


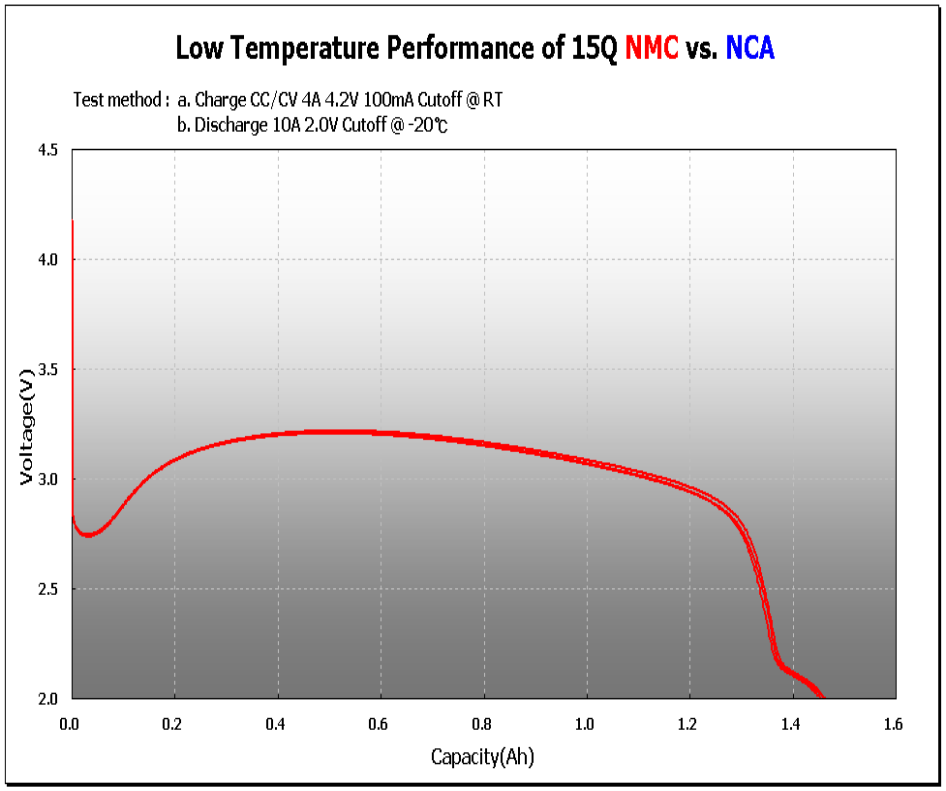
Temperature rise at various discharge current



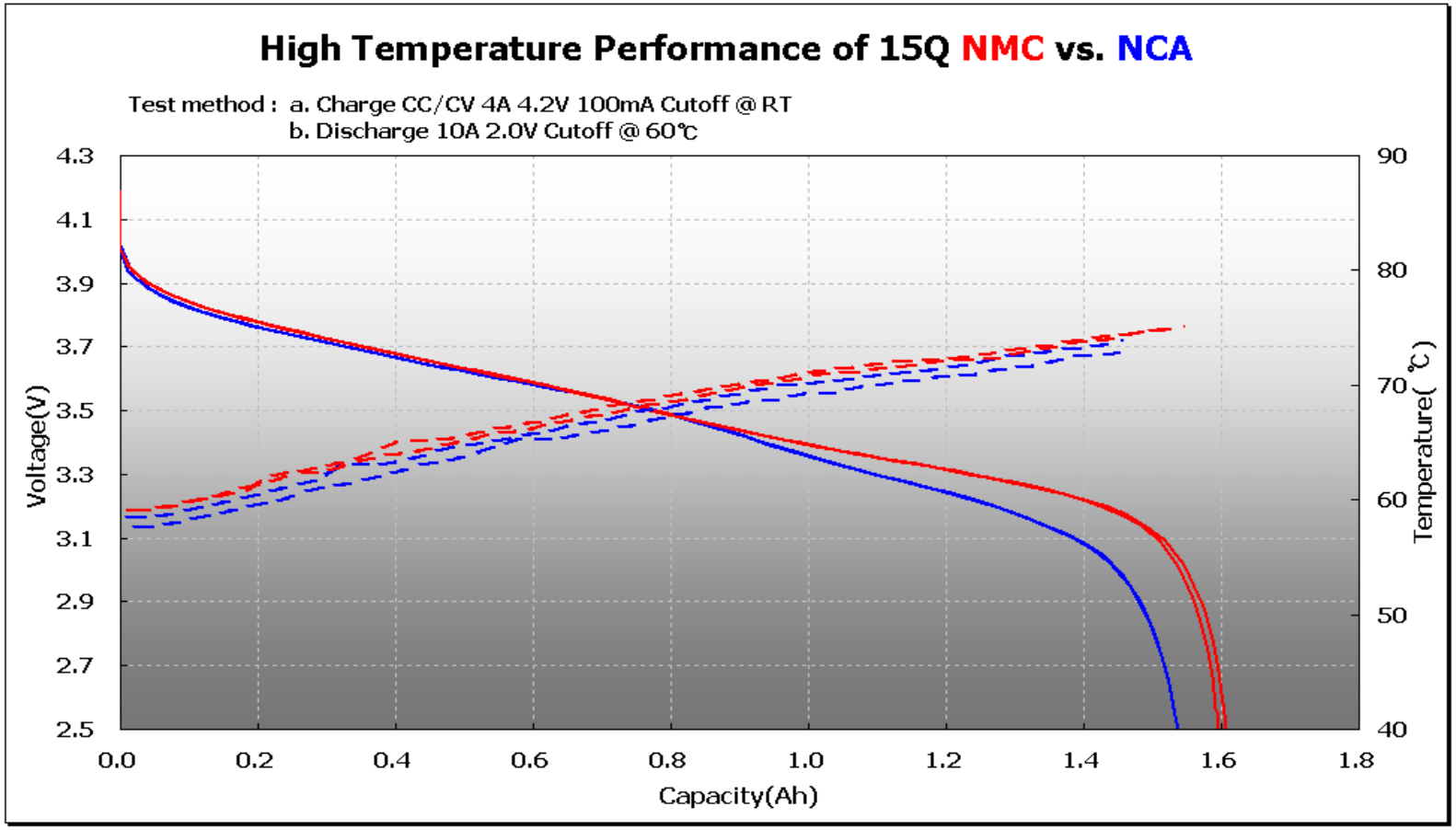
➢ Rate performances of 15Q NMC is similar to NCA

Low temperature performance



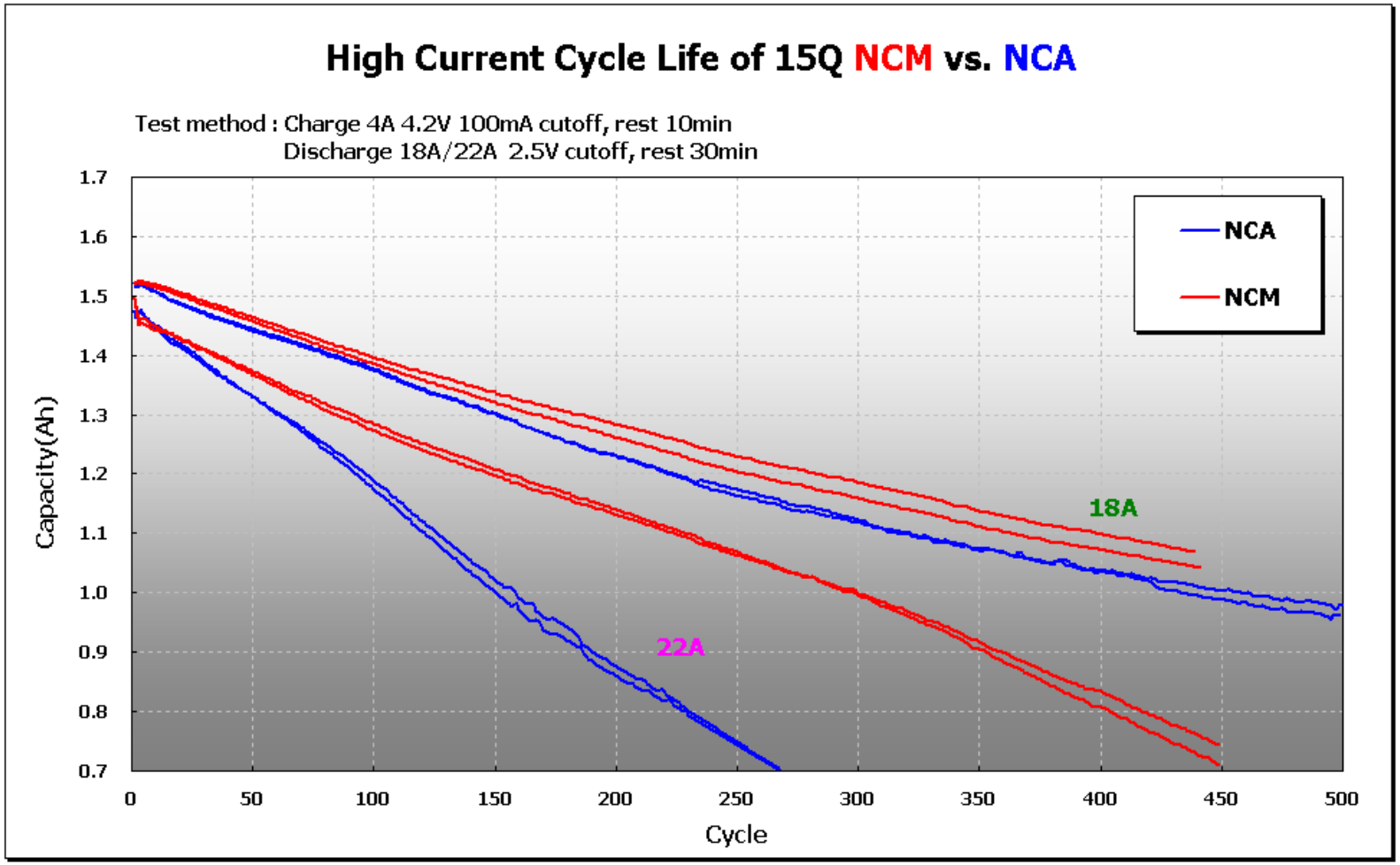


High temperature performance



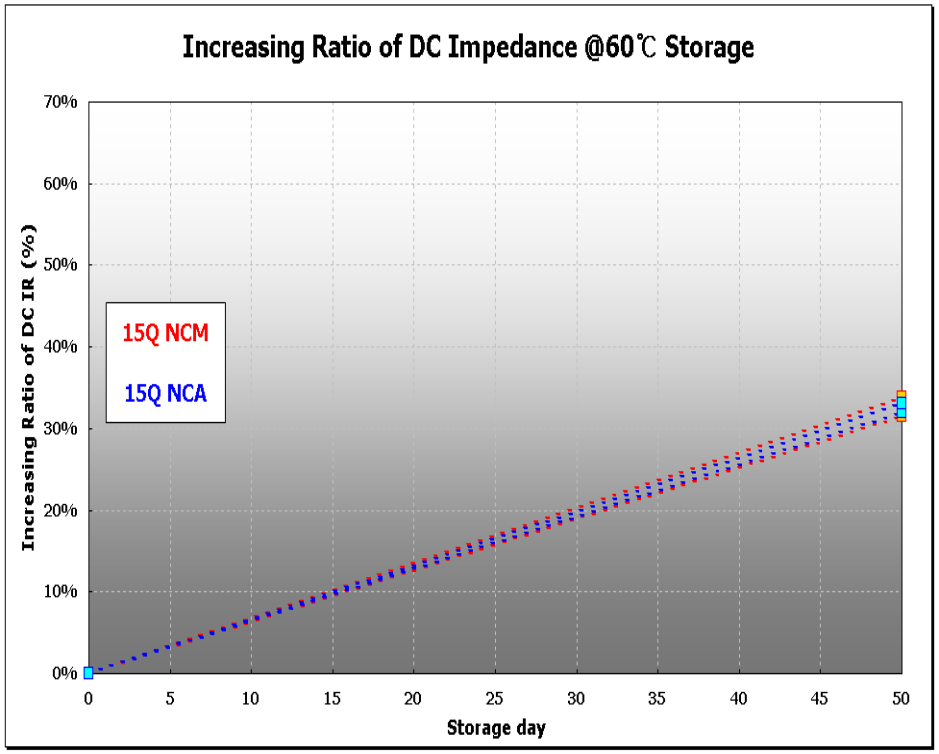
➢ **Similar 10A discharge performance at 60C was shown. (temperature was increased up to 75C)**

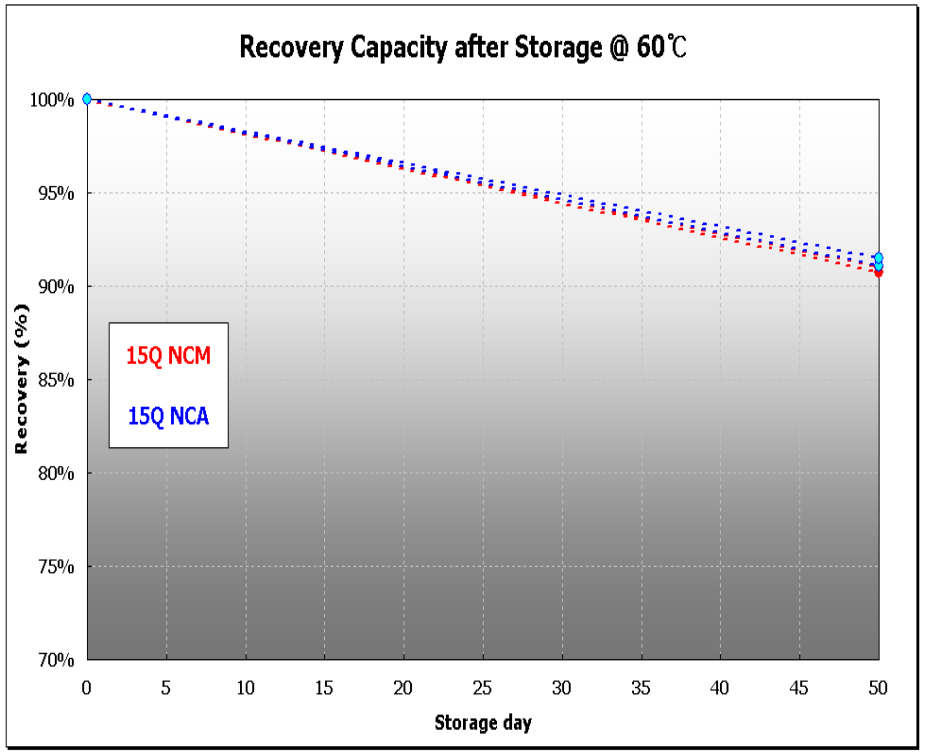
High current cycle life (25℃)



➢ 15L (15Q NMC) has better cycle life at 22A continuous discharge.

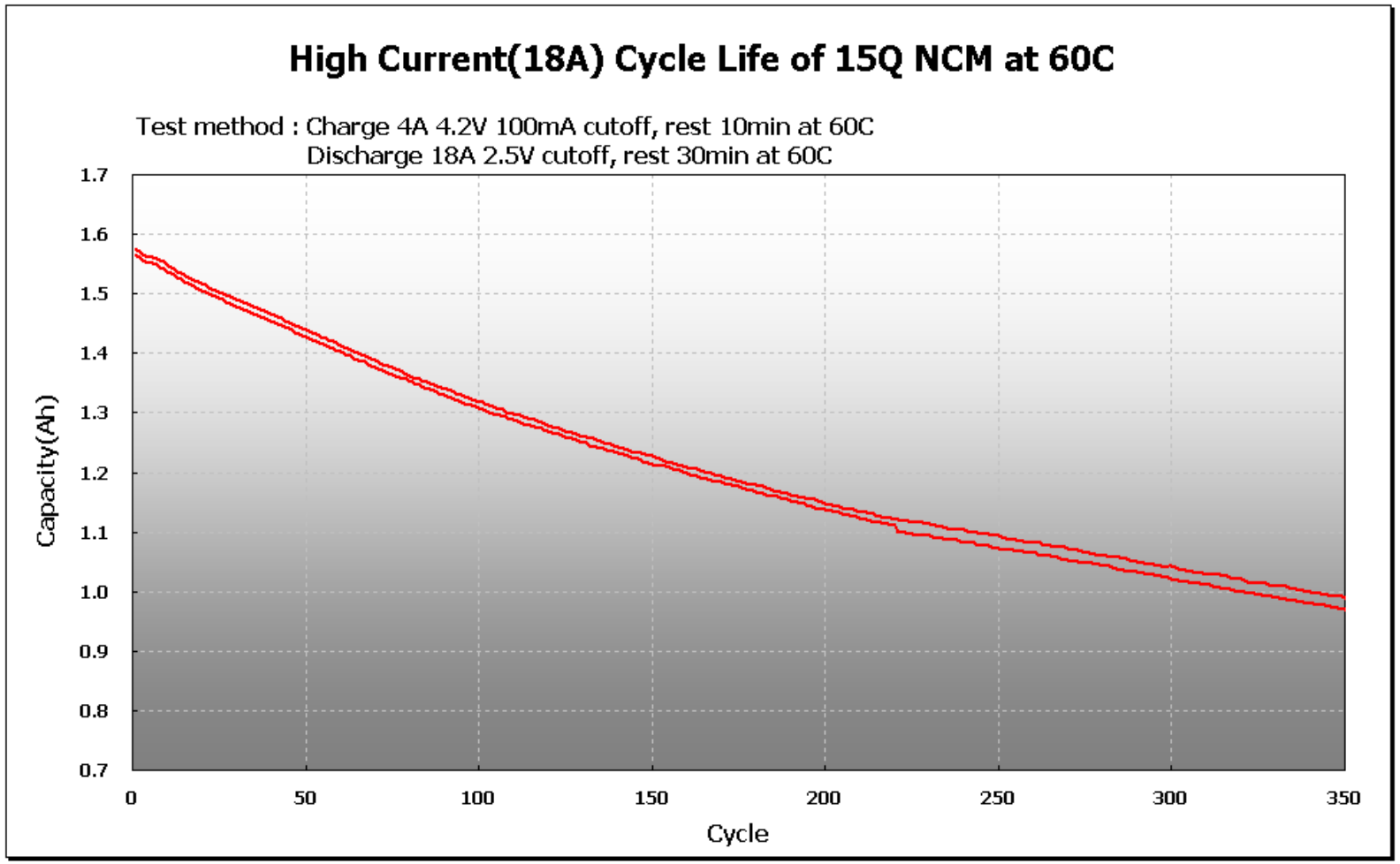
Calendar life characteristics





➢ **Storage characteristics of 15Q NCM is similar to NCA**

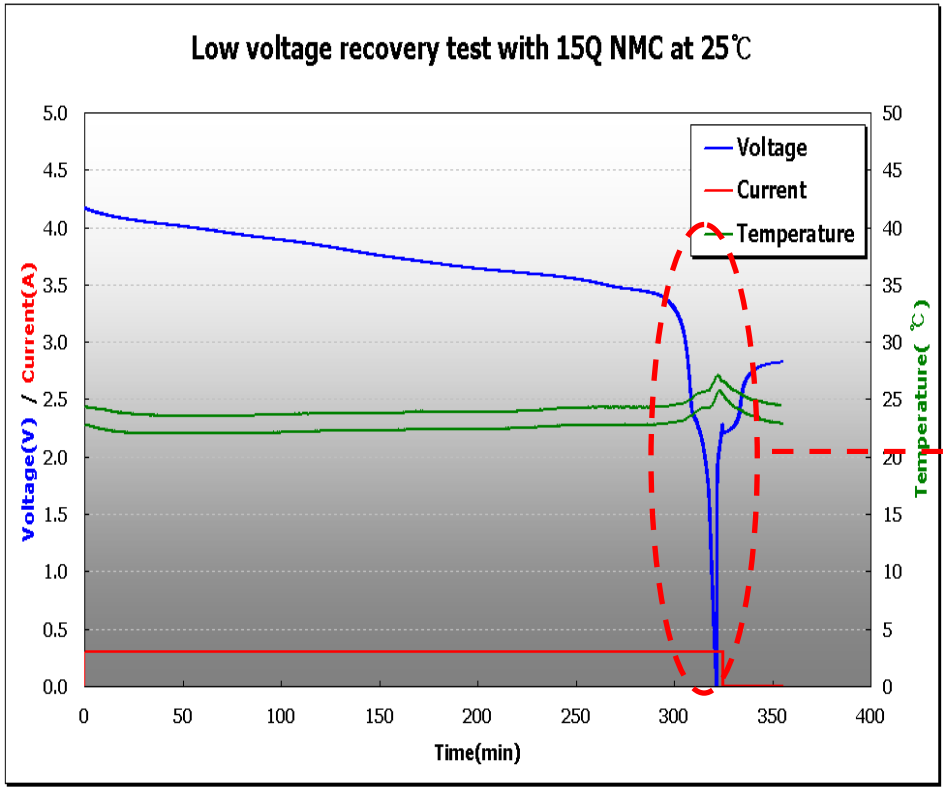
High current cycle life (60℃)

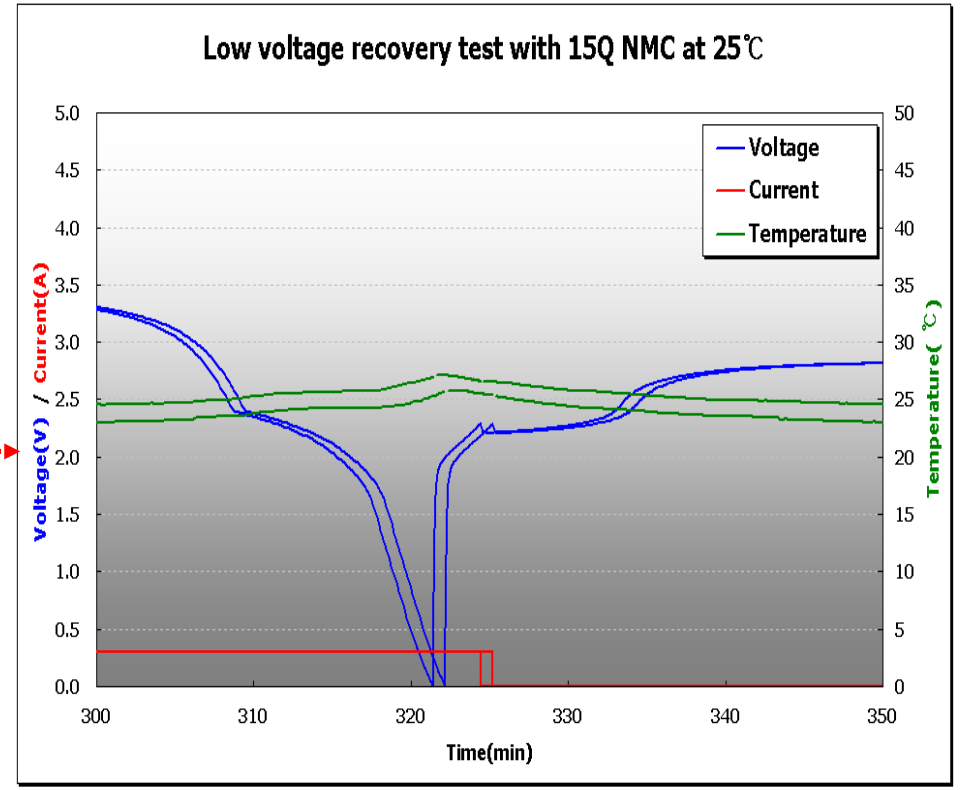


➢ **Cycle life of 15L (15Q NMC) at even 60 degree C is very good**

Low voltage recovery test

Procedure
1) Charge : CC-CV, 4A 4.2V, 100mA Cutoff
2) Discharge : 0.2C, 0V cutoff
3) Charge : 0.3A, 3min. Cutoff
4) Idle : 30min.
5) Ambient temperature : 25℃





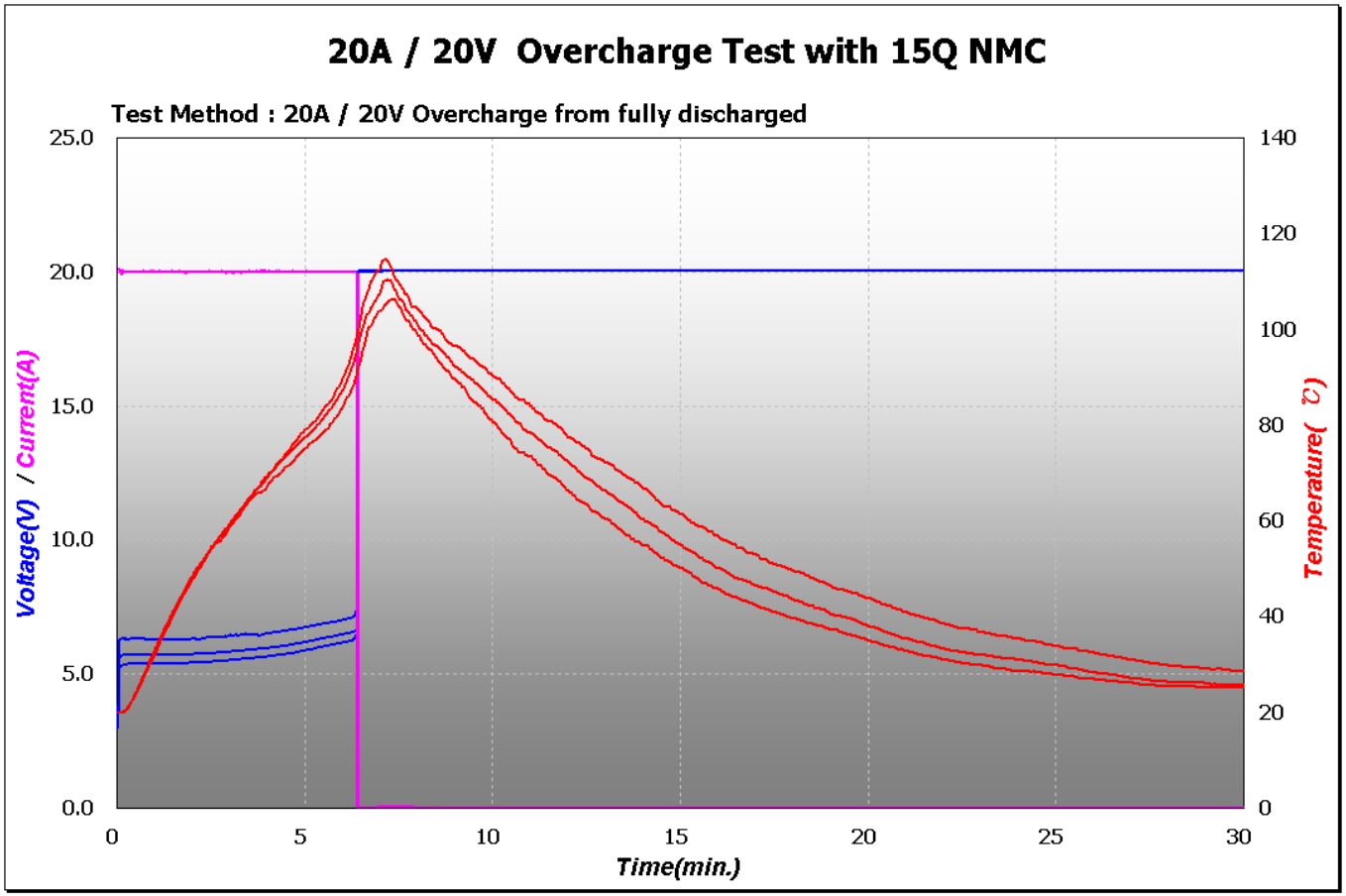
➢ **No damage and recoverable from down to 0V deep discharge**

Safety test results of 15L

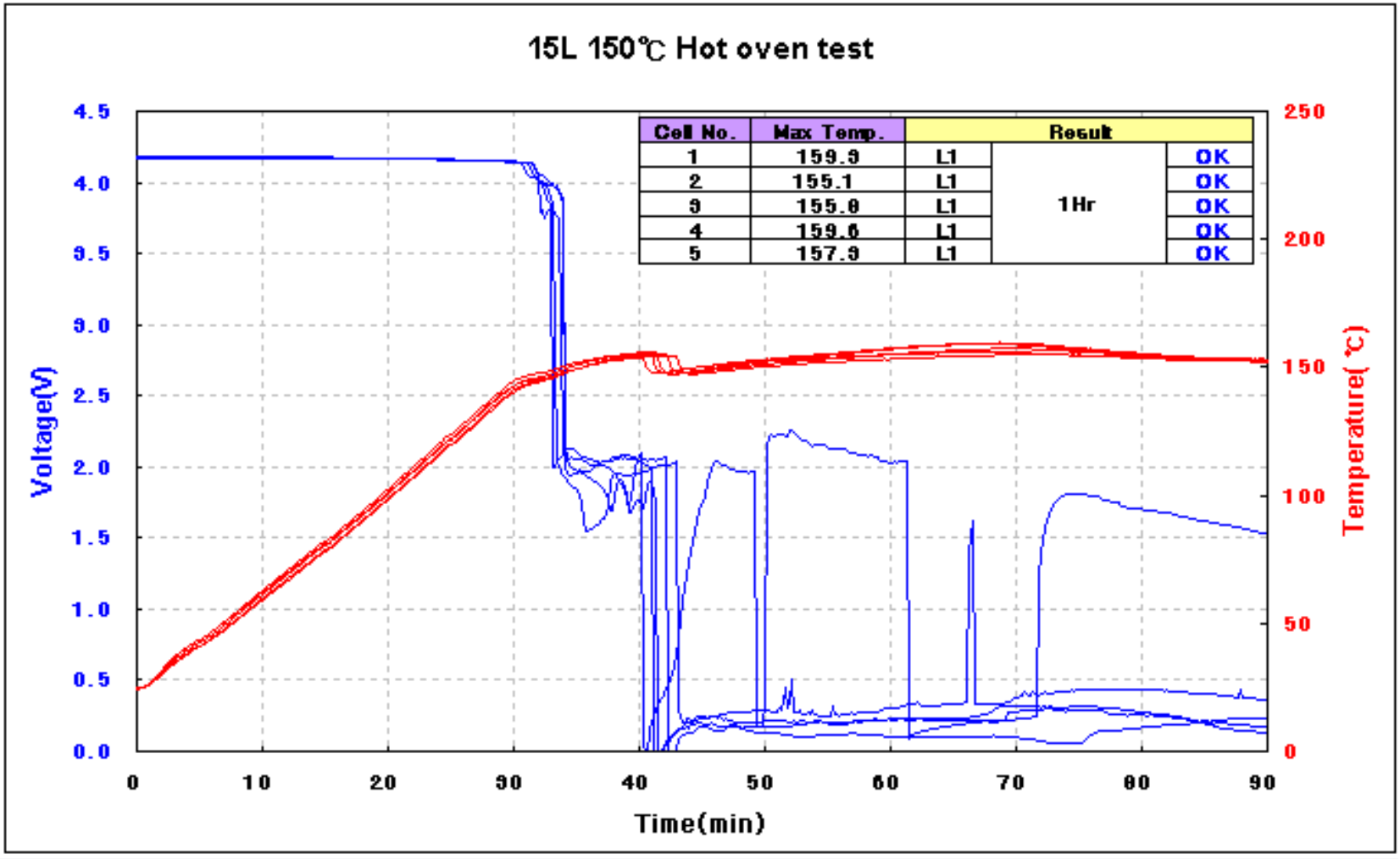
Item		Spec.	Results		OK/NG	Remark
			Results	Max temp.		
Overcharge	20A-20V	L1 ↓	3L1	114.1 ℃	OK	-
Heating(150℃)		L1↓, 10min. standing	3L1	155.9℃	OK	-
Nailing (4.2V, side, full)		L1 ↓	3L1	-	OK	2.5mm, 200mm/sec
Crush (13kN)		L1 ↓	3L0	-	OK	-
Impact (15.8 ¢ , 9.1Kg, 61Cm)		L1 ↓	3L0	-	OK	-

Level	Level0	Level1	Level2	Level3	Level4	Level5
Criteria	No Change	Leak	Smoke, <200℃	Smoke, >200℃	Fire	Explosion

Overcharge test



Hot oven test



Impact, Crush and Nail test

Impact

Crush

Nailing