Technical Note — *Cycle Life of LiPo Packs* — N°: TN06006

Device under test	 **TANIC 5000mAh 5S1P** Weight: 682g Dimension: 160x45x43 mm (Only the lower half of the 10S pack was tested)
Test method ***Test conditions***	a) **Life test** according to PA06002e section 3.2; I_{av} = 30A (6C), I_P = 100A (20C). I_{RMS} = 45A (9C), Vcutoff = 3.1V/cell. No forced air cooling, Ta = 20… 21°C. b) **Intermediate measures:** Discharge with DC current 60A (12C), Vcutoff = 3.1V/cell.

Results

1) Cycle life test; 85 cycles (Fig. 6, 7, 8, 9)

	useful capacity [Ah]	Vm [V/cell]	used energy [Wh]	Ri [mΩ/cell]	temperature rise ΔT [K]
new	4.46	3.57	79.6	3.2	45
50 cycles	4.33	3.56	77.0	3.3	45
100 cycles *)	4.20	3.54	74.3	3.4	45

*) values for 100cycles are extrapolated (Fig. 6)
Initial practical energy density: 117Wh/kg.
About 90% of the rated capacity could be used under the tested conditions.

2) DC discharge (Fig.1, 2)

	12C capacity [Ah]		12C discharge voltage Vm/cell		ΔT [K]
Before LT	4.57	100%	3.54	100%	51
After 22 cycles	4.42	97%	3.53	100%	52
After 38 cycles	4.40	96%	3.51	99%	52
After 65 cycles	4.32	95%	3.51	99%	51
After 85 cycles	4.22	92%	3.50	99%	51

3) Cell matching (Fig.3, 4, 5)
The cell performance was uniform, no mismatch was observed before and after life test.

Conclusions & Comments

- The TANIC cells have a high discharge voltage and a low internal resistance with little degradation during life test.
- The cells were well matched and even after the life test no significant drift was observed, an excellent result (except cell3 but this one had a mechanical damaged -> page 4).
- These features qualify the cells for practical applications with high peak load requirements.
- Under such demanding discharge conditions the loss of capacity reaches 10% after 100 cycles. For a longer cycle life it is recommended to sacrifice part of the useful capacity and to reduce the discharge depth to values below 90%.

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2006-07-29	jb	© slowflyer.ch	*6*

12C intermediate test results

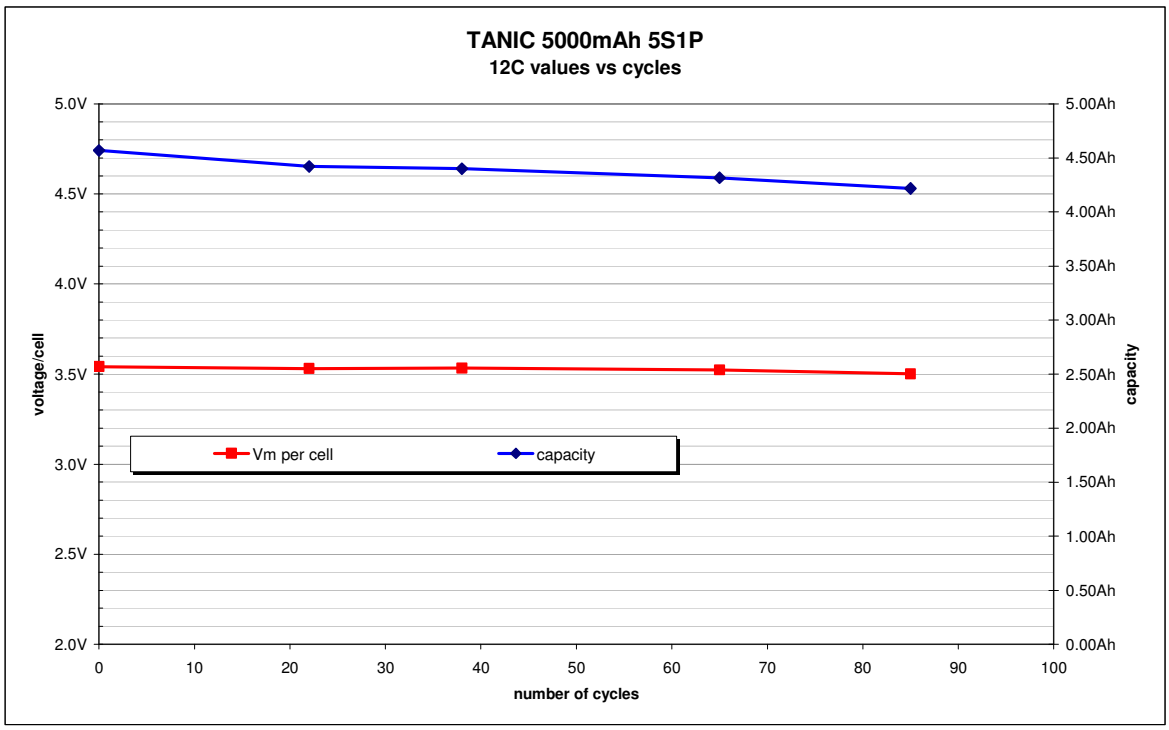

Fig. 1 discharge capacity and average discharge voltage @ 12C vs the number of discharge cycles

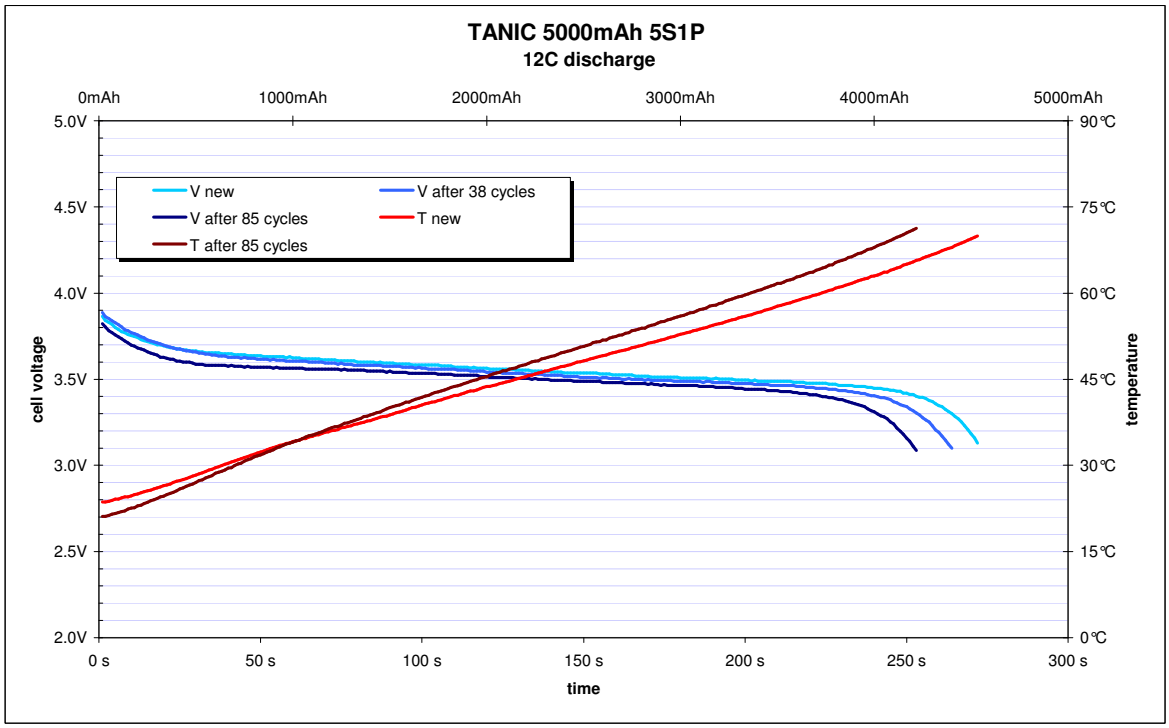

Fig 2. comparison of discharge curves @12C.

Cell voltages

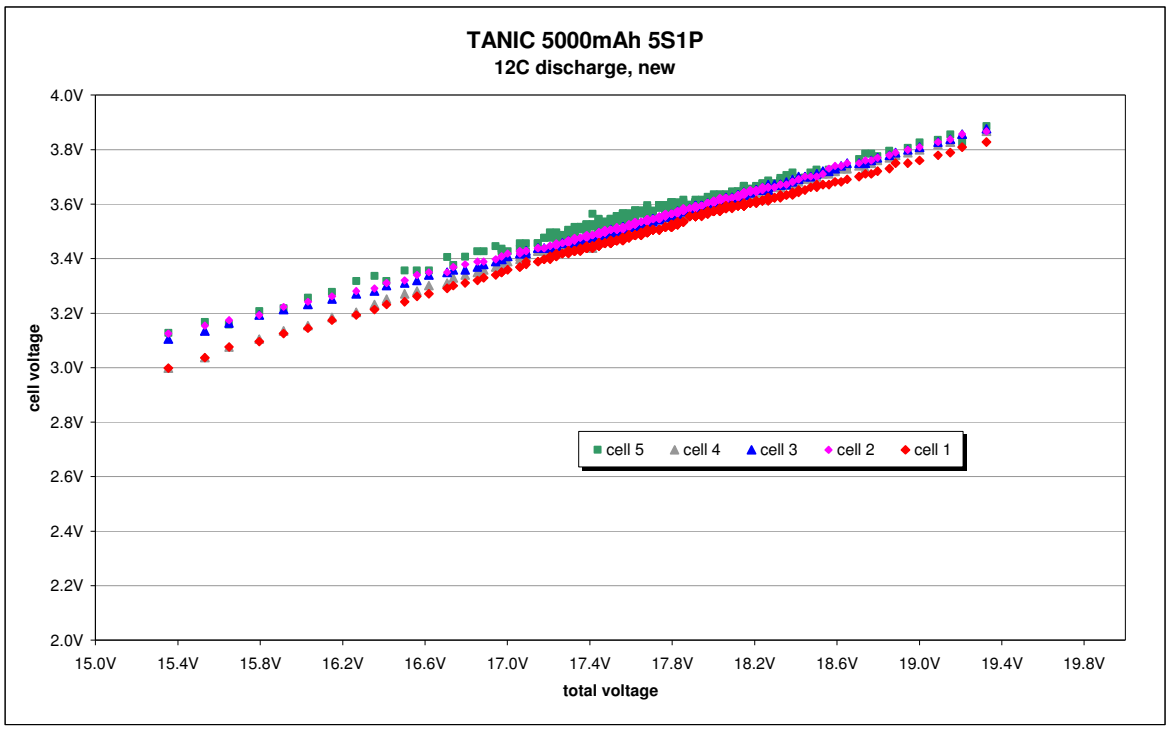

Fig. 3 Individual cell voltages during 12C discharge, initial state

-> A good match!

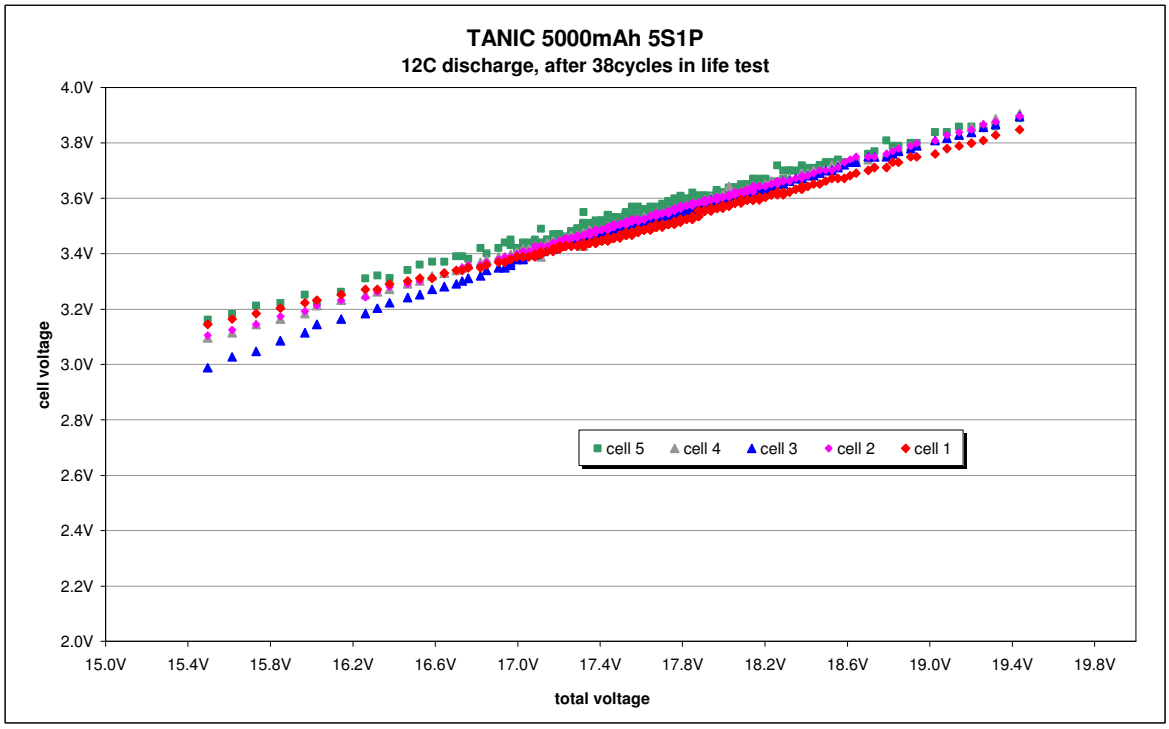

Fig. 4 Individual cell voltages during 12C discharge after 38 cycles in life test.

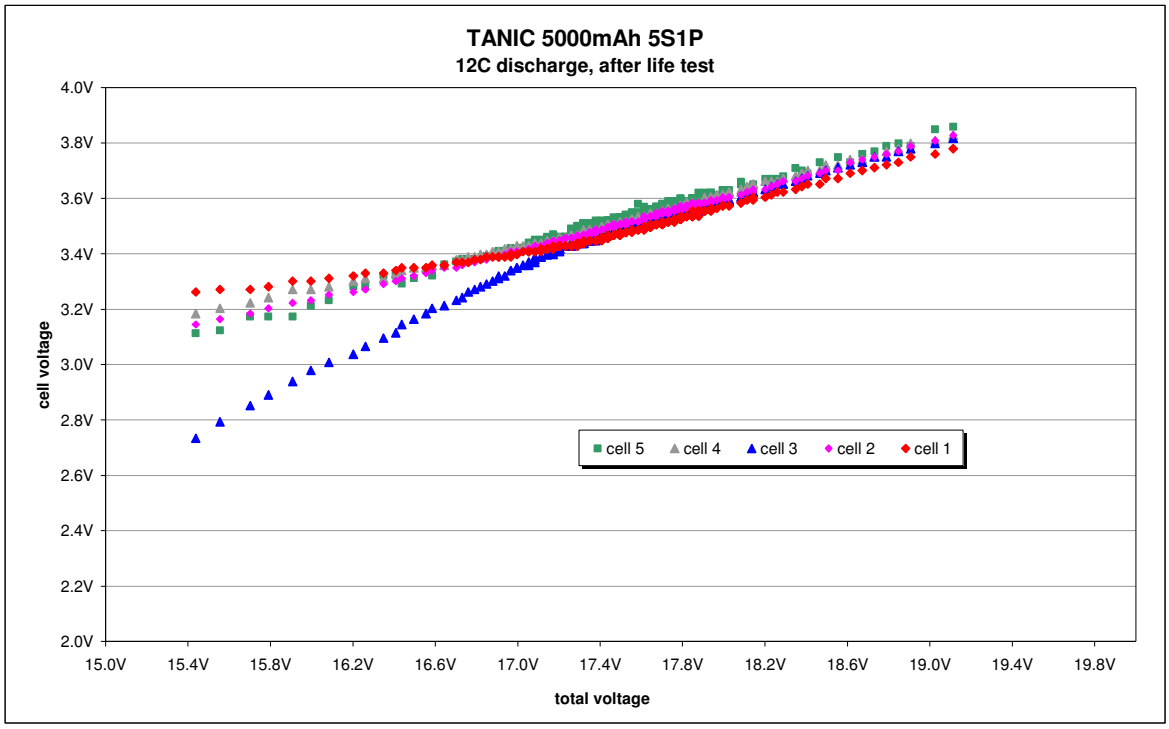

Fig. 5 Individual cell voltages after life test (85 cycles)

Cell 3 differs significantly; it has lost about 5% more capacity than to the others. The reason was most likely a mechanical damage, a small groove at the front end of the cell which was not recognised at first. It must have happened accidentally when the battery pack was prepared for the test.
It was found, that small quantities of electrolyte came out in particular during the discharge phase (temperature rise!). -> Cell 3 must be excluded from the evaluation.

The voltage curves of the other cells are still close together, a good result.

Life test

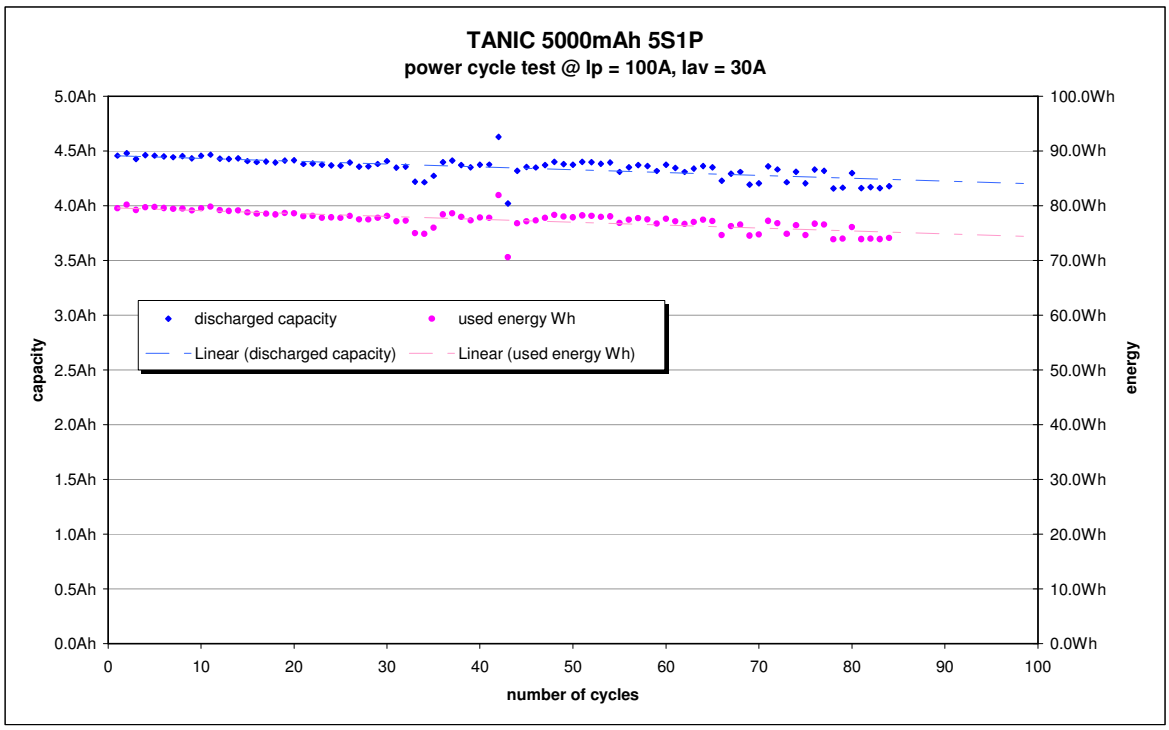

Fig. 6 trend of discharged capacity and energy during life testing

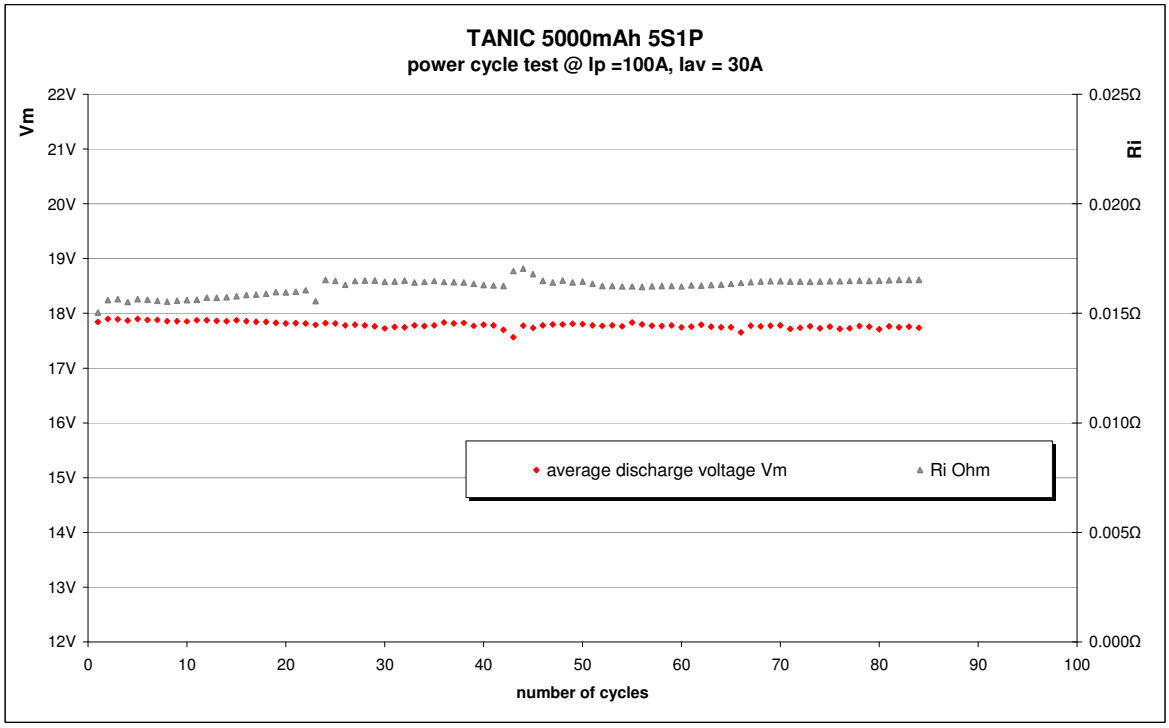

Fig. 7 Ri and average discharge voltage during life testing. The Ri values of this chart were taken between 280s and 310s after start of discharge in each cycle.

Ri increased from 3mΩ/cell to 3.3mΩ/cell while Vm only slightly decreased from 3.57 to 3.54 V/cell.

Internal resistance within a discharge cycle

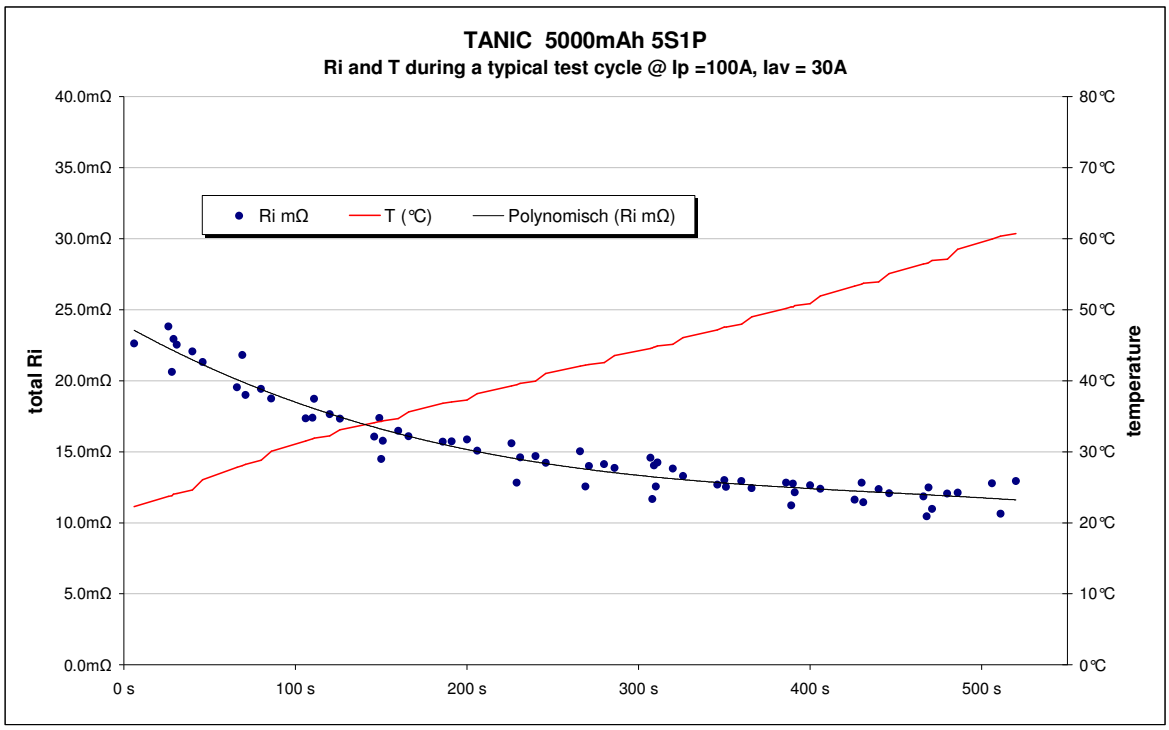

Fig. 8 temperature and Ri at the beginning of the life test

The temperature coefficient of Ri is moderate, the minimum of Ri (less than 3 mΩ) is reached at the end of the discharge periode while at the beginning Ri is around 5mΩ.

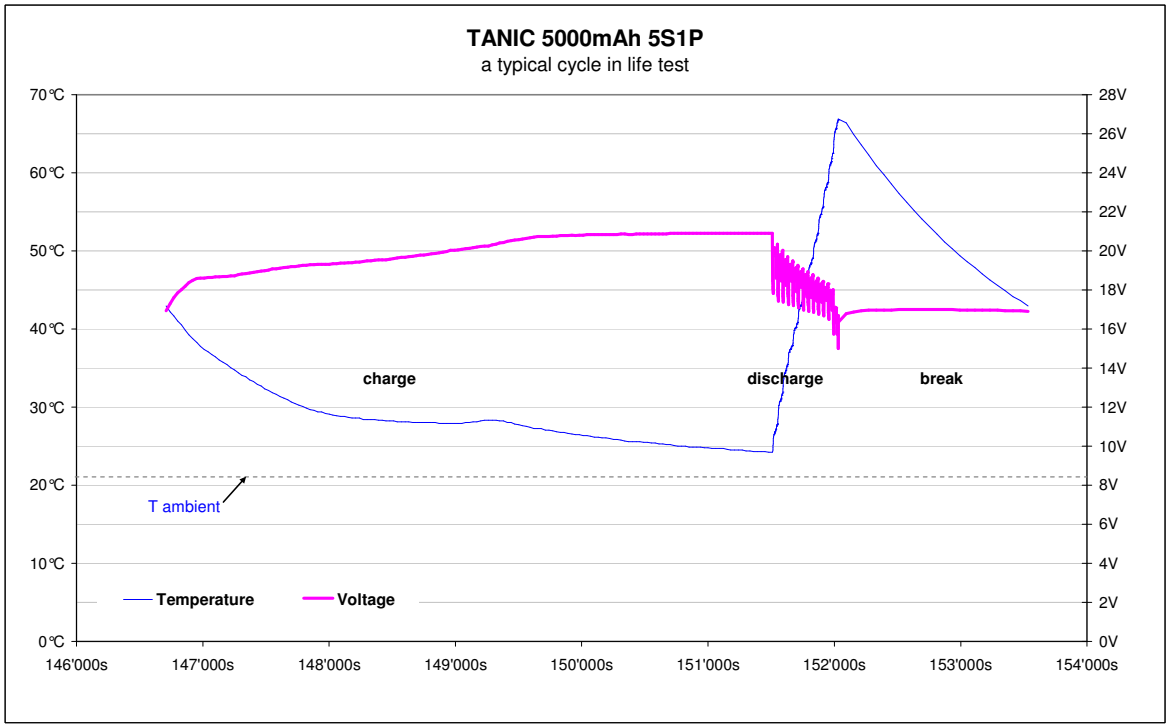

Fig. 9 a complete cycle in life test