

ANTE-MORTEM ANALYSIS AND AGEING TESTING OF SOTA CYLINDRICAL LITHIUM-ION CELLS



OVERVIEW

For the **iModBatt project** an extensive market search on high energy cylindrical cells was performed. A set of eight cells was identified, based mostly on energy density and lifetime. These cells were analyzed in depth through

- ante mortem material characterization,
- electrical and thermal benchmarking,
- cycle life.

The main findings of this investigation regarding **ante mortem analysis** and **cycle life** are presented in this work.

CELL SELECTION AND PROPERTIES

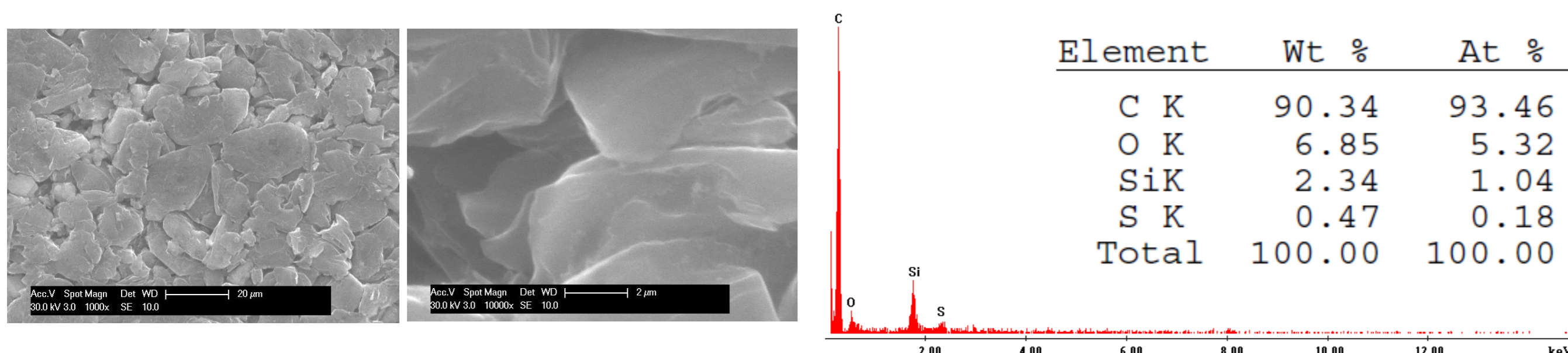
Applying the criteria from above, **three type 18650** and **five type 21700** cells were identified. 21700 cells generally offer higher energy density. Six cells came from Asia and two from Europe. The table gives datasheet values and those obtained by ante mortem analysis.

Models	Energy density (Wh/kg)	Country	Anode*	Cathode*
SAMSUNG INR21700-48G	250,4	Korea	Graphite + 1%wt Si	NCA
SONY 21700-52EM	267,4	Japan	Graphite	NCA
PANASONIC NCR18650B	248,7	Japan	Graphite	NCA
SAMSUNG INR18650-35E	252,0	Korea	Graphite + 1%wt Si	NCA
LG INR18650 MJ1	259,6	Korea	Graphite + 1%wt Si	NCM
LG INR21700 M50	263,0	Korea	Graphite + 1%wt Si	NCM811
SAMSUNG INR21700-50E	260,9	Korea	Graphite + 1%wt Si	NCA
SONY 21700-50EL	257,0	Japan	Graphite	NCM811

*combined results from EDX/XRD analysis

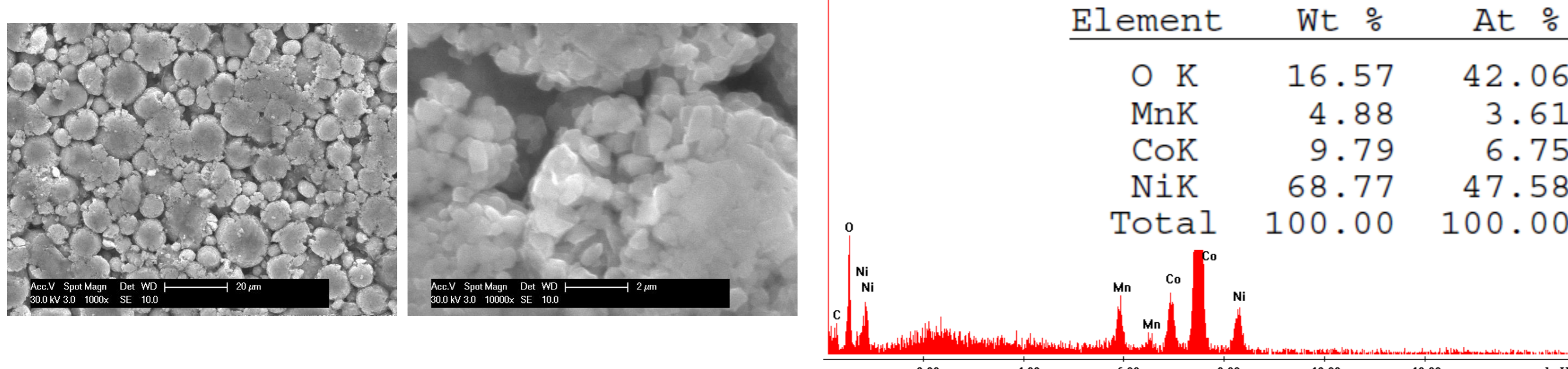
ANTE MORTEM ANALYSIS

Analysis of the Anode



Graphite based anodes in all cells, traces of Silicon (~1%wt) and Sulphur (<1%wt) in five cells.

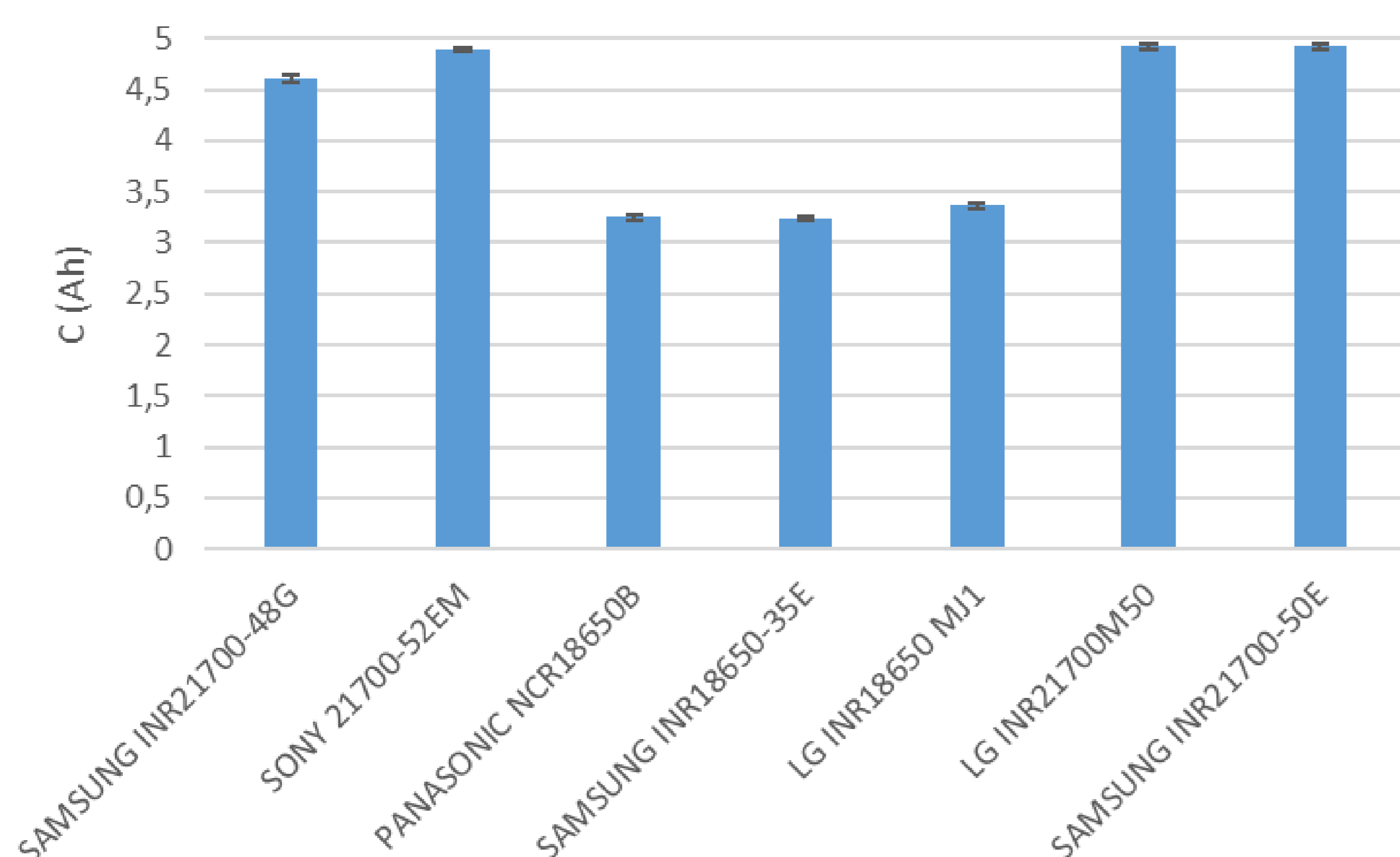
Analysis of the Cathode



Various compositions found. A trend towards low Manganese content is clearly observable.

INITIAL BENCHMARK

1C discharge with CC/CV to minimum voltage until I<C/20

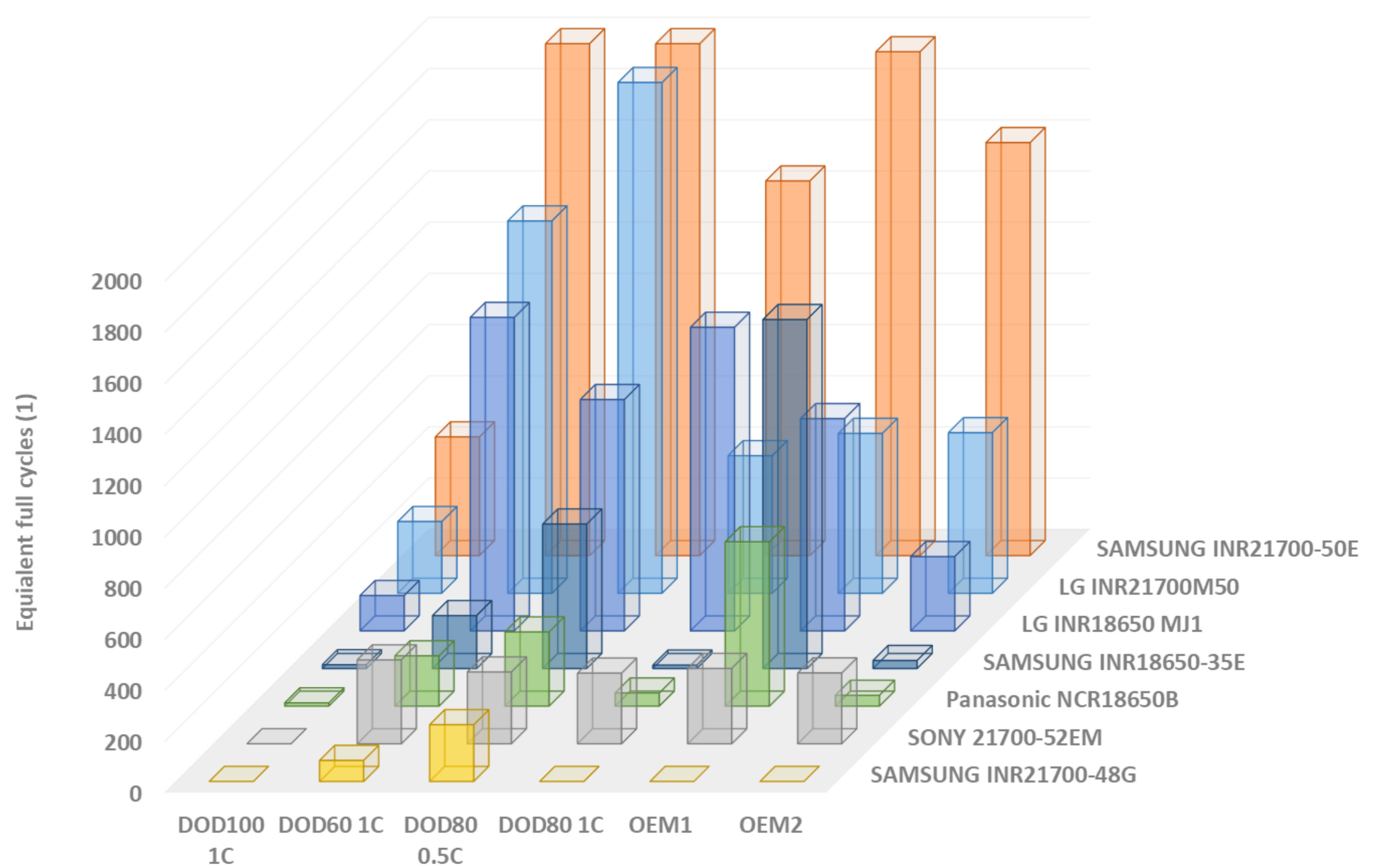


- All cells perform close to or above their nominal value
- Best 21700 cell capacities range up to 5Ah
- Very homogeneous capacity values among samples

CYCLE LIFE TESTS

The cells were cycled according to requirements of OEMs → **Out of boundary conditions for some cells.**

Different C-rates and DODs were chosen for cycling, and 2 OEM profiles with slow and fast charging were executed. Cells were cycled with CC/CV for charge and CC for discharge. Every 75 full cycle equivalents a checkup was performed.



*some values extrapolated by linear fit

DISCUSSION

- Traces of Silicon (~1%wt) and Sulphur (<1%wt) are found in five of eight high energy anodes.
- Trend towards low Manganese content in cathodes is observed.
- Samsung INR21700-50E shows the best combination of results regarding the demands defined for automotive application considering energy, power and aging behavior → Selected for the iModBatt project
- Charge rates of 1C and above (outside manufacturers' recommendations) and full cycles led to the quickest degradation.

ACKNOWLEDGEMENTS

The iModBatt project has received funding from the European Union's Horizon2020 Programme for research and innovation under Grant Agreement No. 770054.

