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SIMCAL Project: calendar aging results obtained on a panel of 6 commercial Li-ion cells

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**Introduction**

Battery performances degrade over time, not only due to their charge/discharge profile, commonly called ‘cycling ageing’, but also at rest, commonly called ‘calendar ageing’ [1–4]. This second type of ageing is much less studied than the first one, probably due to the fact that the purpose of a battery is precisely to be charged / discharged. Many efforts have thus been made by battery manufacturers to improve ageing in cycling. Moreover, we intuitively expect a greater impact on ageing of cycling compared to rest time. However, time spent at rest can be significant in many applications. This is the case of vehicles (including electric vehicles) which stay at rest approximately 90% of their time (in parking mode). This is why the SIMCAL Project, conducted by 14 French partners, focused on the study of calendar ageing during 3 years.

This communication establishes a synthesis of performance obtained, and describes the main aging mechanism understood thanks to post-mortem analyses.

**Experimental**

The SIMCAL study focused on a panel of 7 commercial battery technologies, including 1 NiMH and 6 Li-ion cells references, among which 1 CNCA, 1 C/NMC, 1 C/LMO-NMC, and 3 C/LFP. Only results obtained on Li-ion cells are discussed in this communication, the case of the NiMH being too specific to be compared to Li-ion results. The table below gives the general characteristics of the 6 Li-ion cells tested.

**Results and discussion**

The Fig. 1 presents the calendar ageing results obtained on 6 commercial Li-ion cells (Tab. 1) according to the 9 conditions previously mentioned (3T × 3 SOC).

**Conclusion**

Results obtained in the SIMCAL Project confirm the necessity to address the calendar ageing when one wishes to forecast the lifetime of batteries. This type of ageing may even become the dominant ageing factor depending on the temperature and the SOC usage profile. Moreover, this ageing mode is not representative of one application and its study is hence useful for virtually all applications. This type of ageing is also particularly interesting since it may even become the dominant ageing factor depending on the temperature and the SOC usage profile. Finally, post-mortem analyses have helped to better understand the ageing mechanisms involved in calendar ageing, mainly ruled by the loss of cyclable Li considering the autopsied cells.

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**References**