Study of the operation of Lead-Acid Battery Electrodes under hybrid battery-electrolyzer cycling profiles

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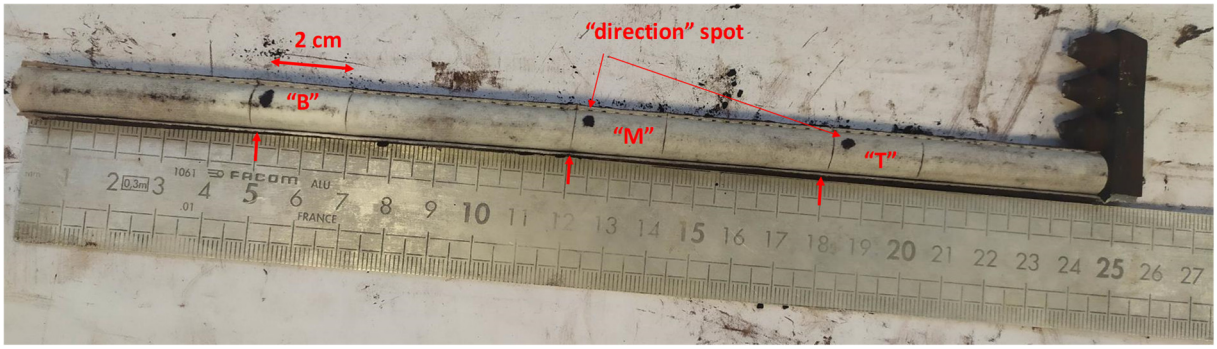
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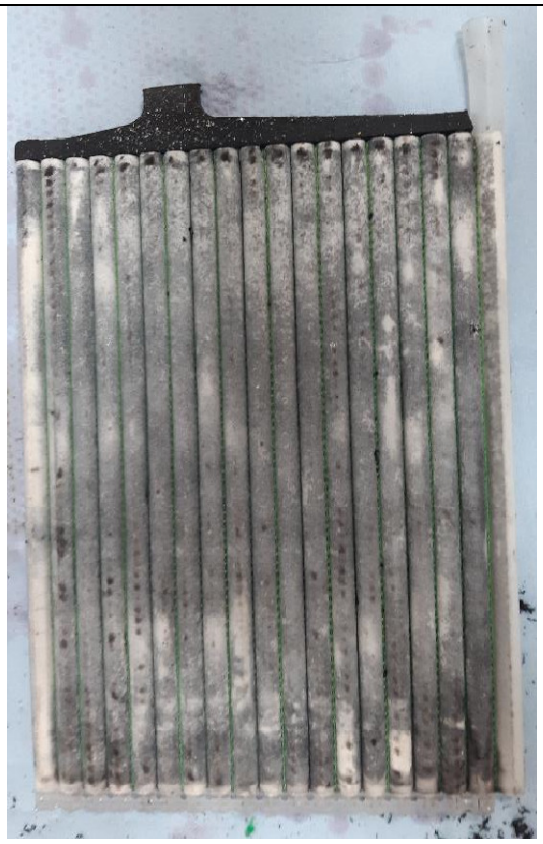
Supplementary information



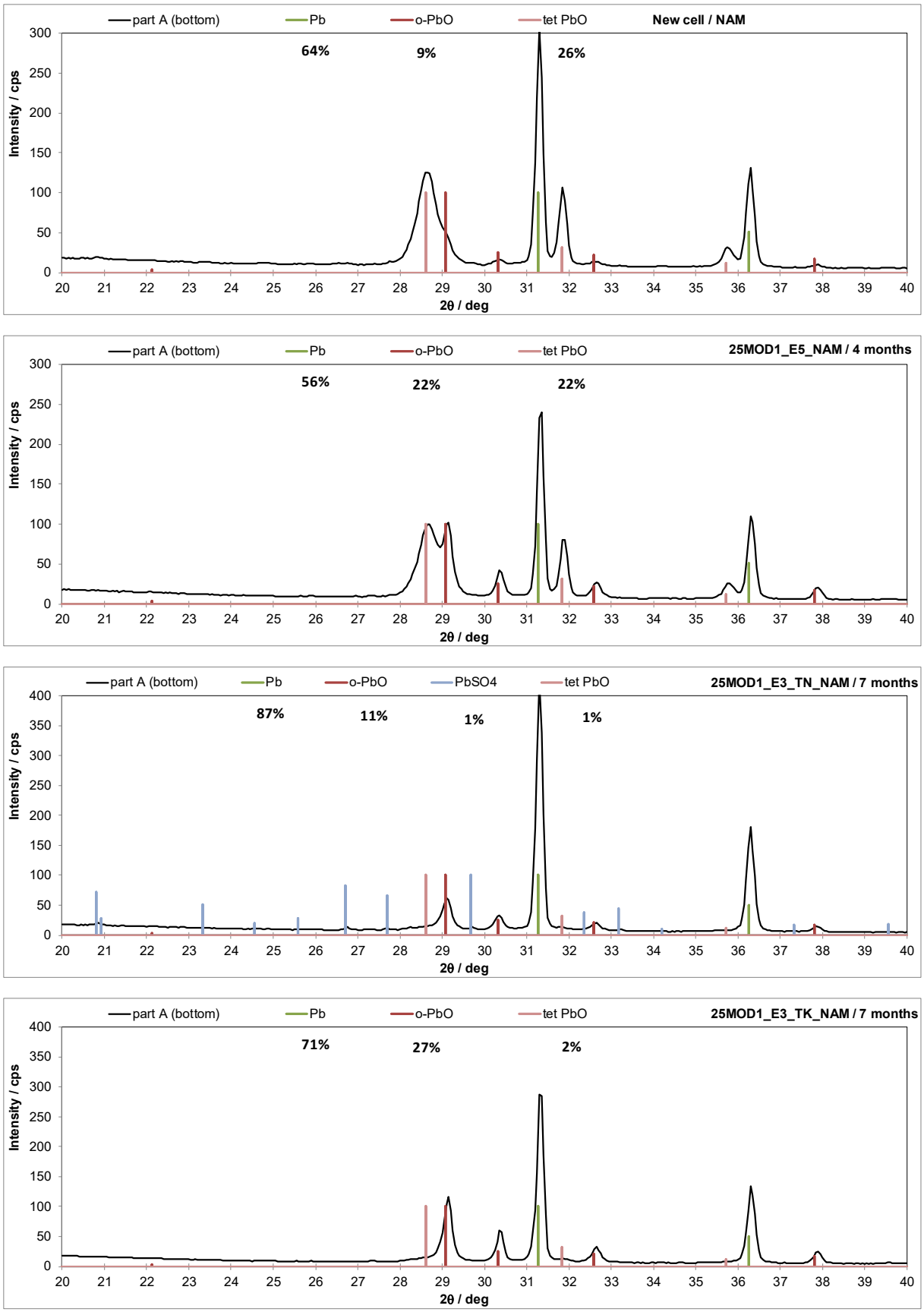
S1a. Digital image of washed and dried positive tubular electrode from a new cell. The gauntlet indexed as #1 is cut and the positive active material is detached from the spine. The spine is cut to the length of 223mm +/-1mm, together with the other three indexed #2, #3 and #4. The gauntlet without index is kept entire for microscopy samples preparation.



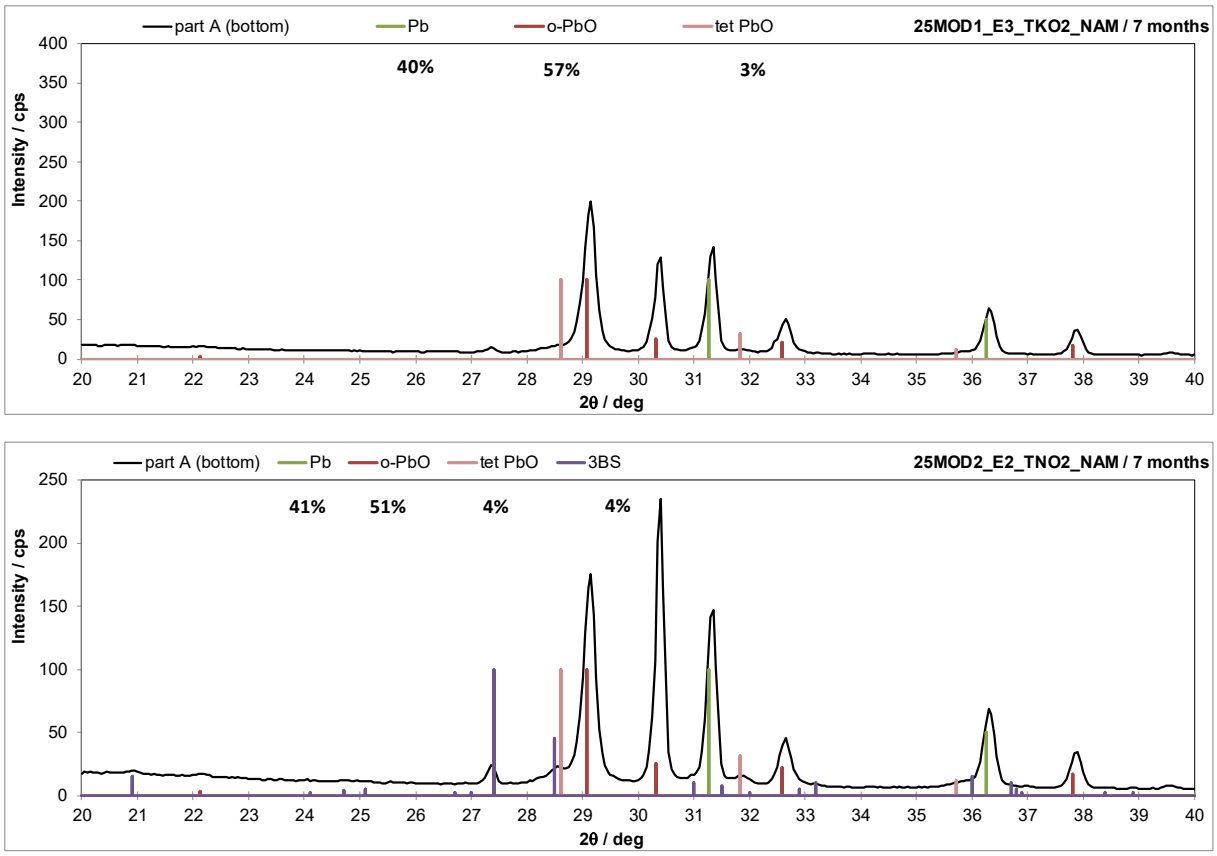
S1b. Digital image of an entire gauntlet prepared for cutting, in order to get samples for optical metallographic observations. The cross-section to be observed is indicated with red arrow and letter stating Bottom, Middle and Top position.

New cell		
5 months of ageing		 • Fissured, swollen and deformed gauntlets • Corrosion layer scaling-off from the top lead horizontal bar

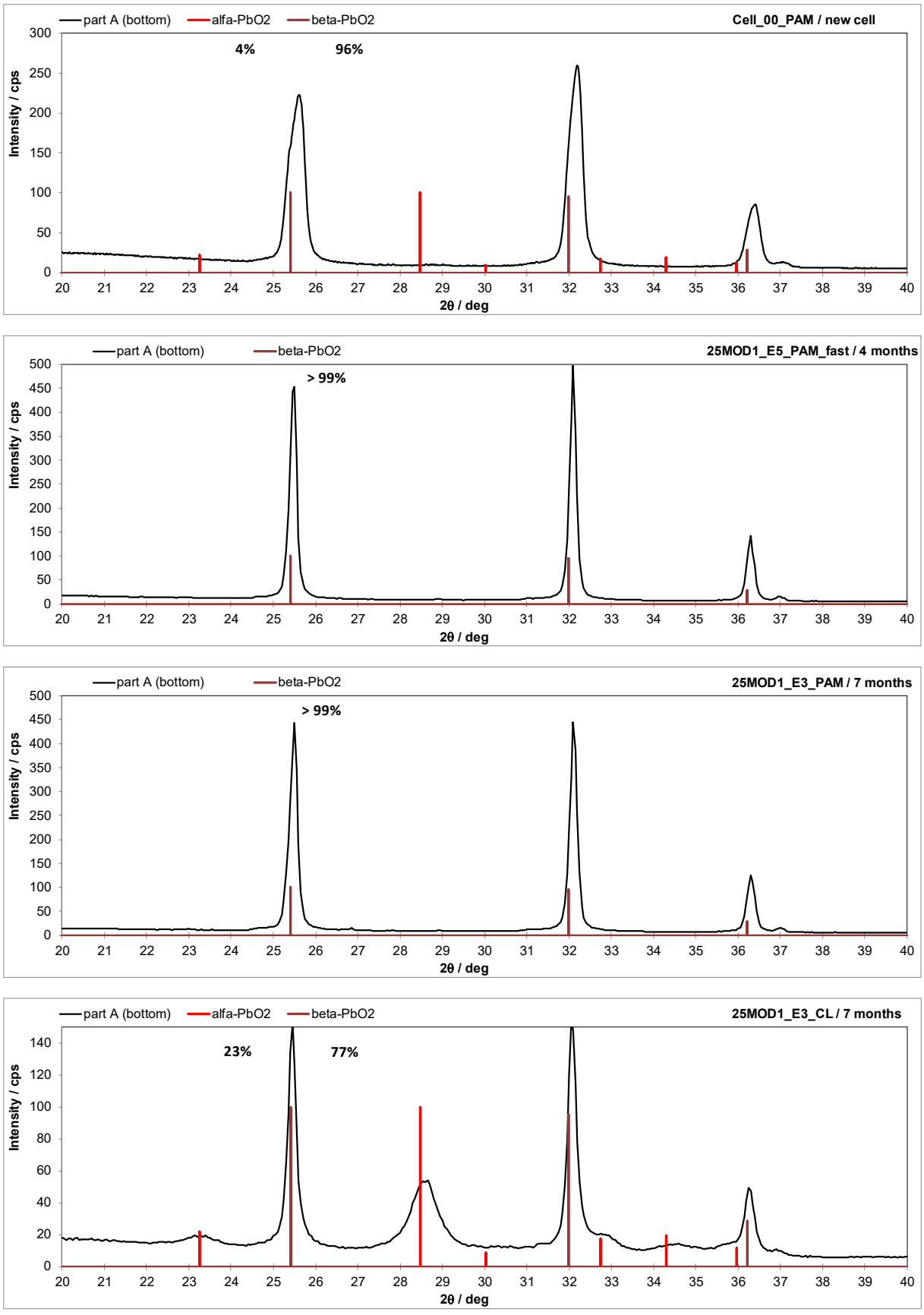
S2. Images of negative (left) and positive (right) electrodes extracted from new cell and from a cell operated as part of the string 25MOD4 during 5 months.



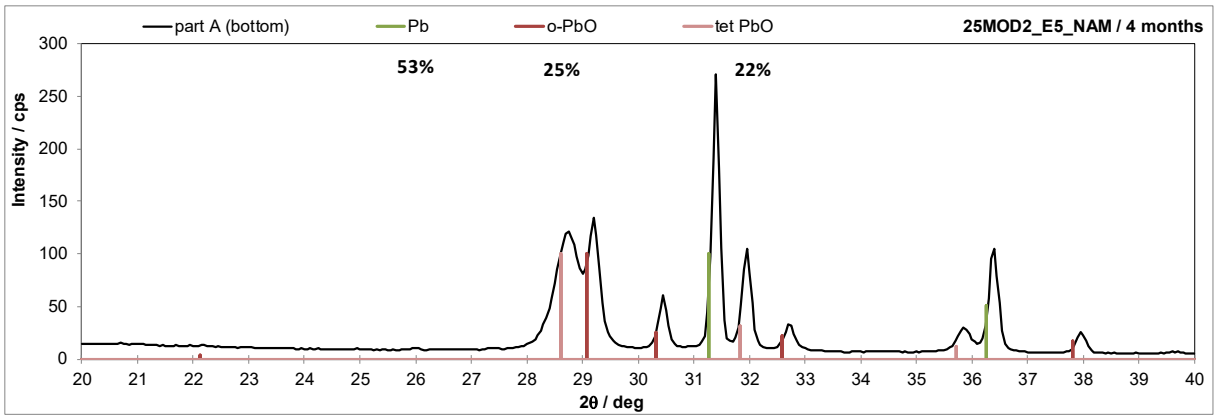
S3. X-diffraction patterns of negative active materials from cells underwent 0, 4 and 5 months of aging at cycling protocol 25MOD1. “TK” indicates a sample from the internal thicker negative electrode. The samples are consecutively washed with tap water, ethanol and acetone.

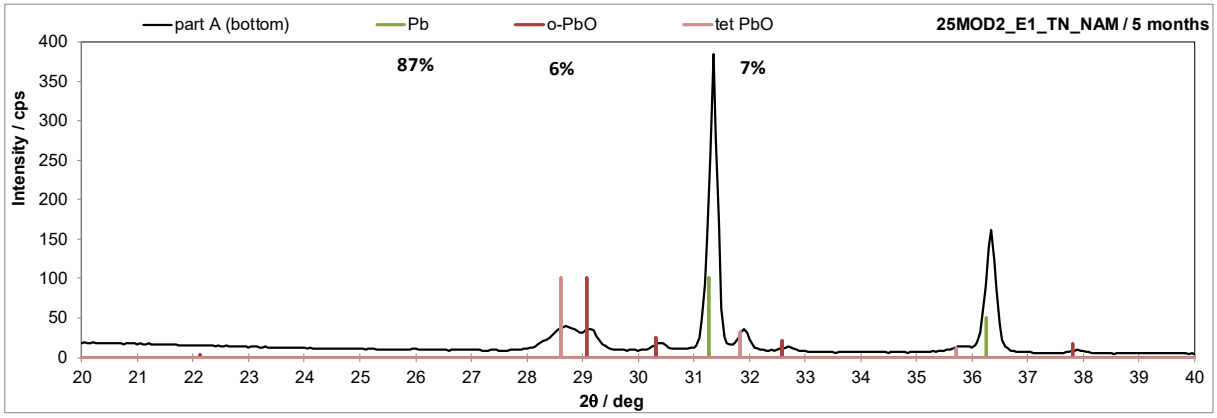


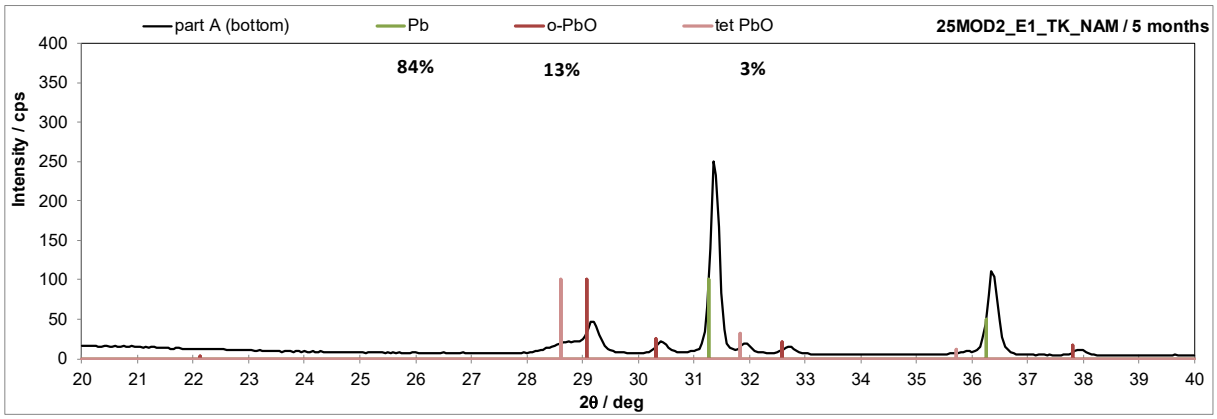
S4. X-diffraction patterns of negative active materials from the cell underwent 5 months of aging at cycling protocol 25MOD1. “TK” indicates a sample from the internal thicker negative electrode. The samples are washed with tap water and air-dried at 60°C.

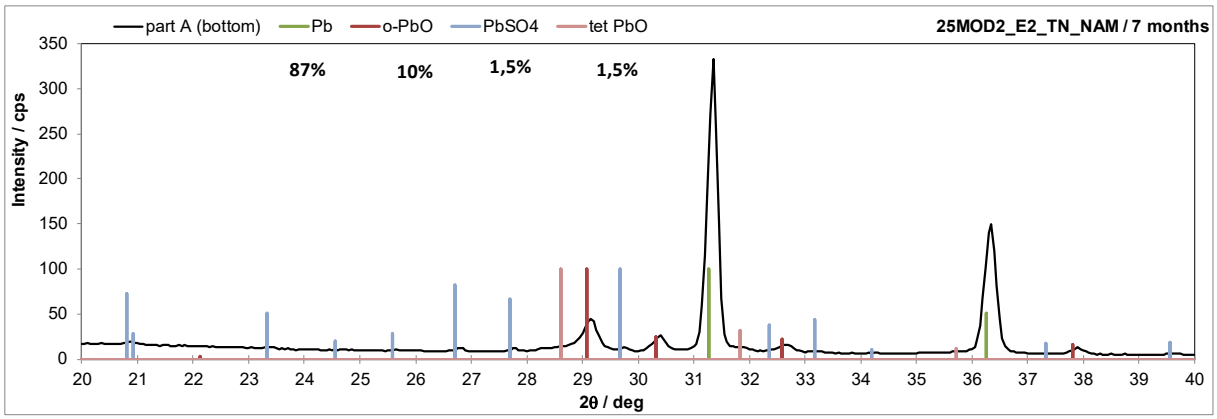


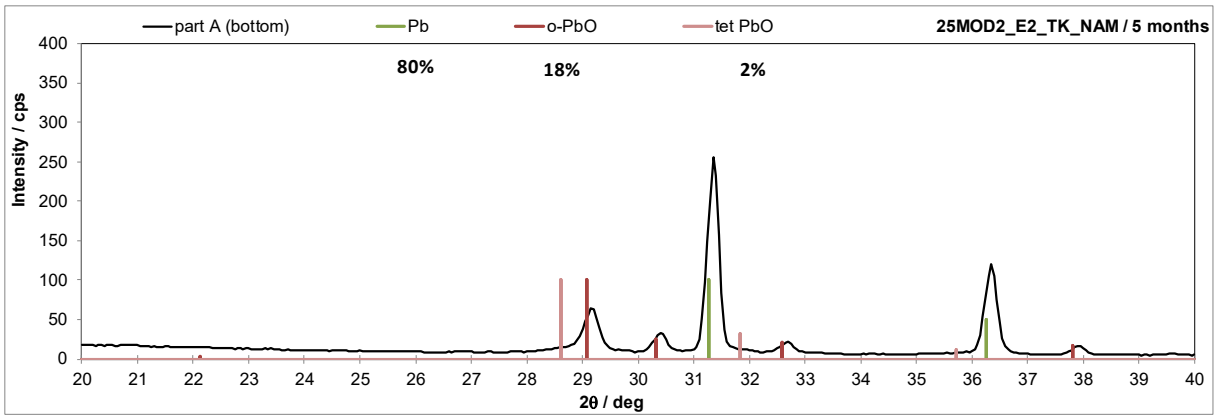
S5. X-diffraction patterns of positive active materials from cells underwent 0, 4 and 5 months of aging at cycling protocol 25MOD1. “CL” refers to a sample prepared from the corrosion later of the positive current collector after the removal of the bulk part of the PAM.


part A (bottom)
Pb
o-PbO
tet PbO
25MOD2_E5_NAM / 4 months
53%
25%
22%
Intensity / cps
2θ / deg

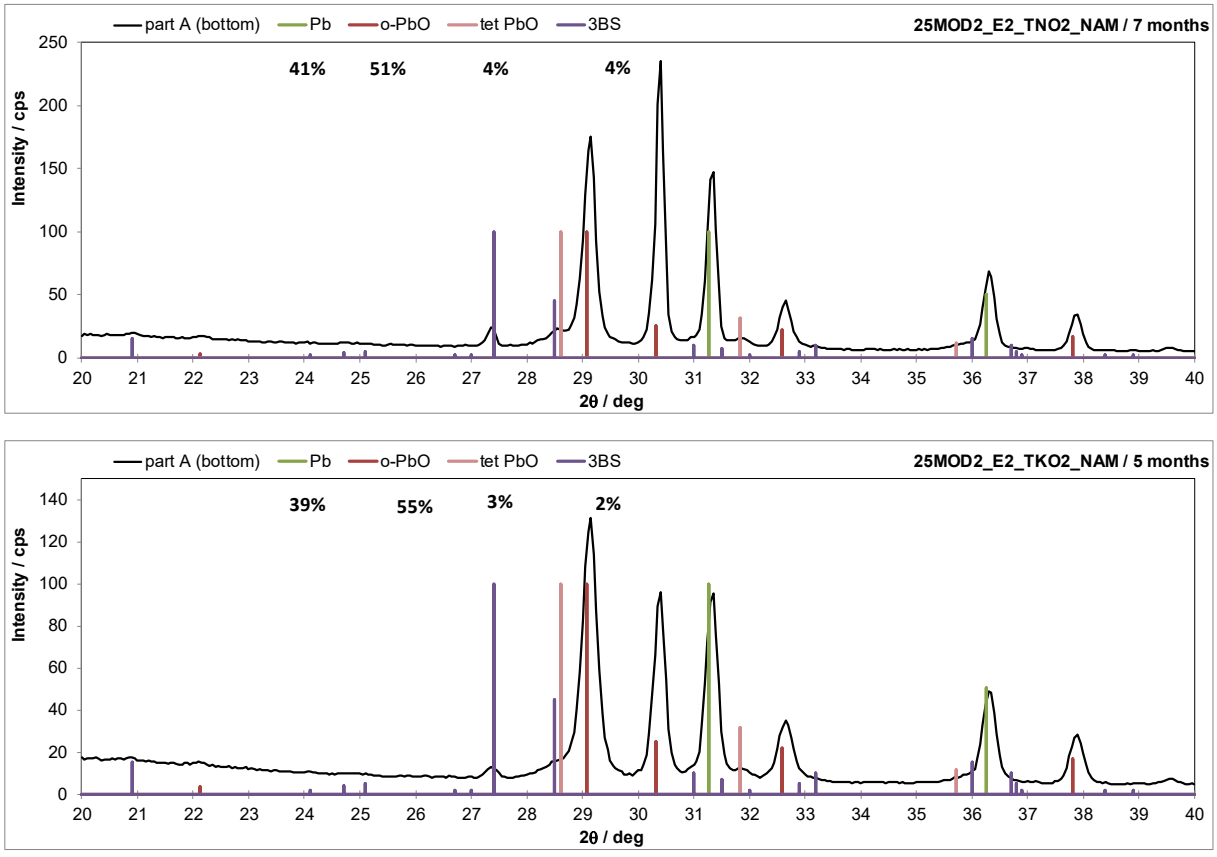

part A (bottom)
Pb
o-PbO
tet PbO
25MOD2_E1_TN_NAM / 5 months
87%
6%
7%
Intensity / cps
2θ / deg


part A (bottom)
Pb
o-PbO
tet PbO
25MOD2_E1_TK_NAM / 5 months
84%
13%
3%
Intensity / cps
2θ / deg

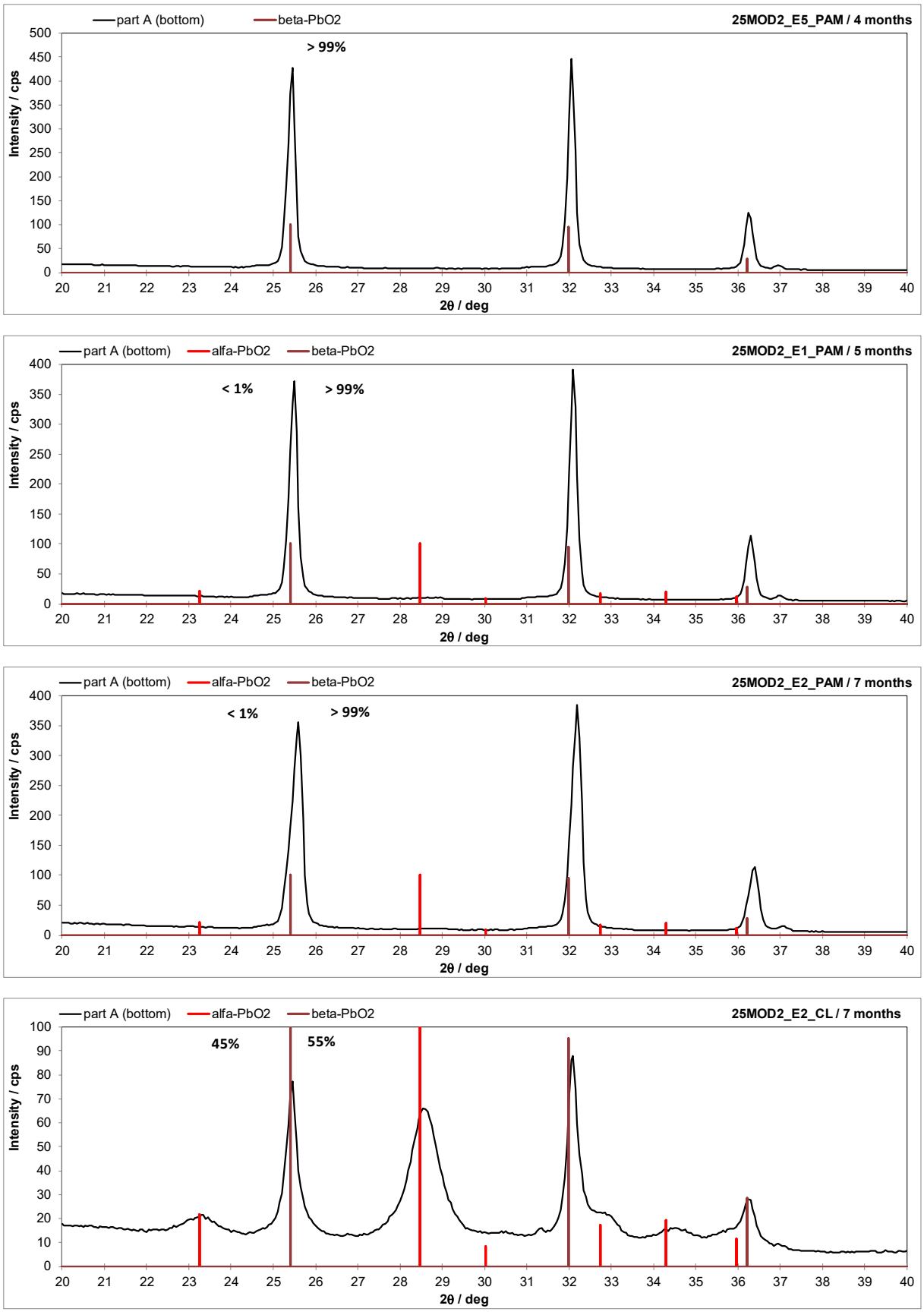

part A (bottom)
Pb
o-PbO
PbSO4
tet PbO
25MOD2_E2_TN_NAM / 7 months
87%
10%
1,5%
1,5%
Intensity / cps
2θ / deg



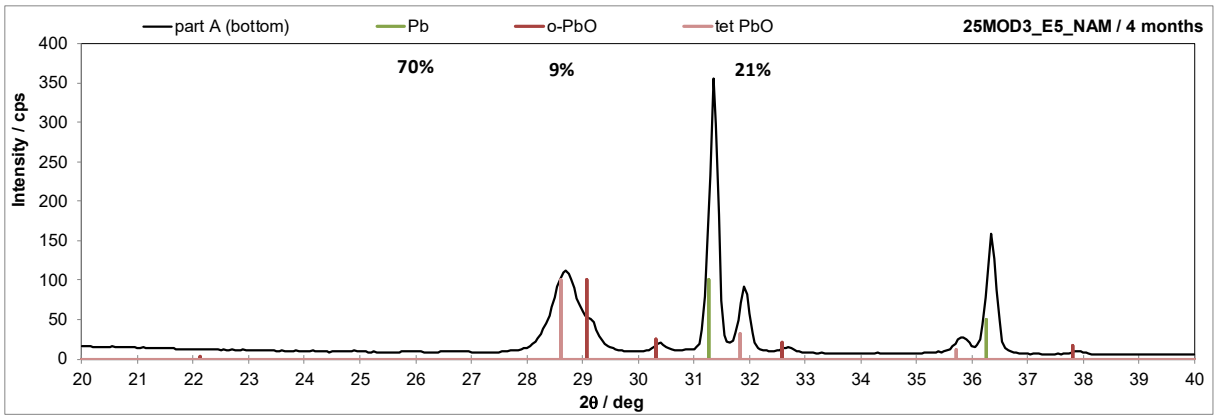
S6. X-diffraction patterns of negative active materials from cells underwent 4, 5 and 7 months of aging at cycling protocol 25MOD2. “TK” indicates a sample from the internal thicker negative electrode. The samples are consecutively washed with tap water, ethanol and acetone.



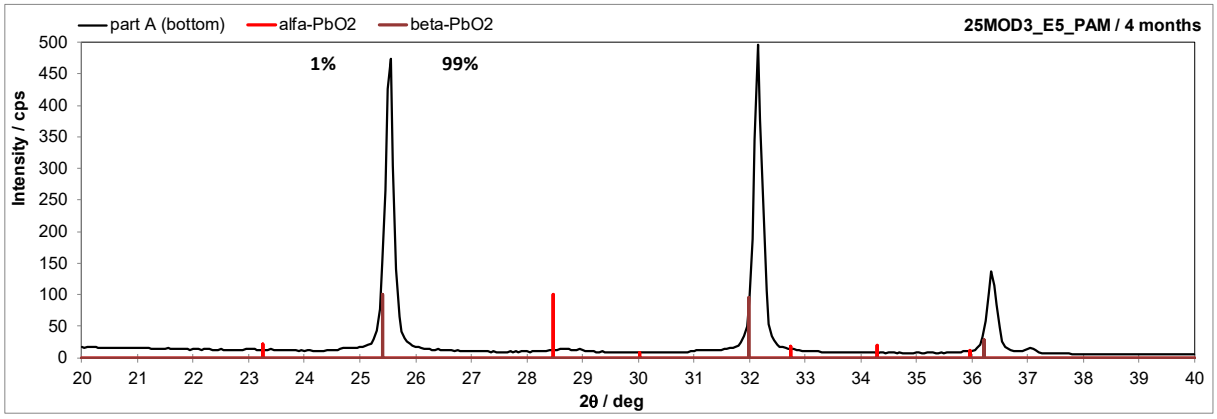
S7. X-diffraction patterns of negative active materials from the cell underwent 7 months of aging at cycling protocol 25MOD2. “TK” indicates a sample from the internal thicker negative electrode. The samples are washed with tap water and air-dried at 60°C.



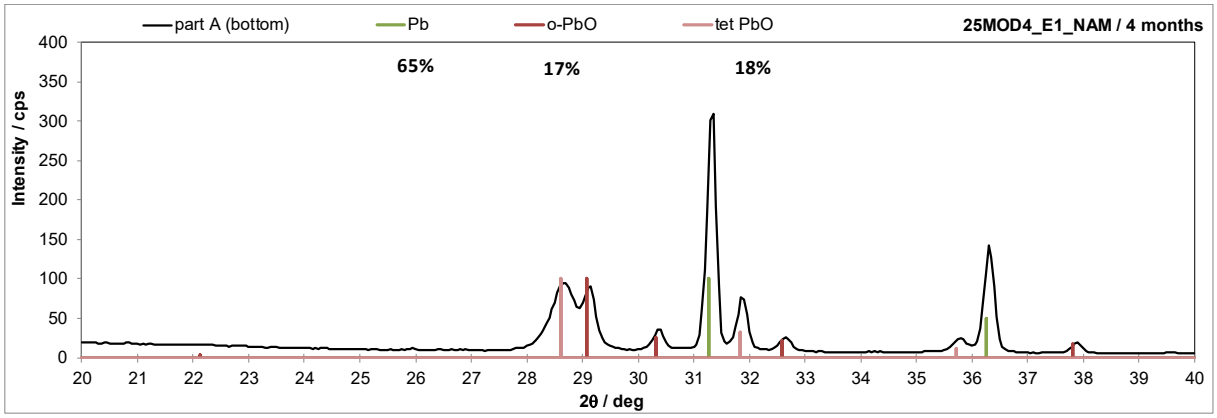
S8. X-diffraction patterns of positive active materials from cells underwent 4, 5 and 7 months of aging at cycling protocol 25MOD2. “CL” refers to a sample prepared from the corrosion later of the positive current collector after the removal of the bulk part of the PAM.



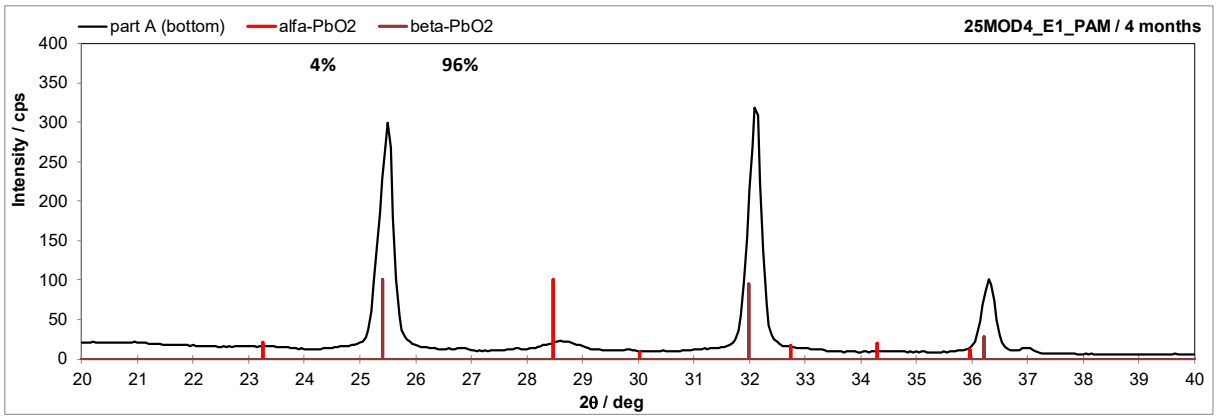
S9. X-diffraction patterns of negative active material from a cell underwent 4 months of aging at cycling protocol 25MOD3. The sample is consecutively washed with tap water, ethanol and acetone before 16h long drying in air at 60°C.



S10. X-diffraction patterns of positive active material from a cell underwent 4 months of aging at cycling protocol 25MOD3.



S11. X-diffraction patterns of negative active material from a cell underwent 4 months of aging at cycling protocol 25MOD4. The sample is consecutively washed with tap water, ethanol and acetone before 16h long drying in air at 60°C.



S12. X-diffraction patterns of positive active material from a cell underwent 4 months of aging at cycling protocol 25MOD4.