Inorganic oxide composites as high temperature CO_2 sorbents with enhanced cycle stability

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Supporting information

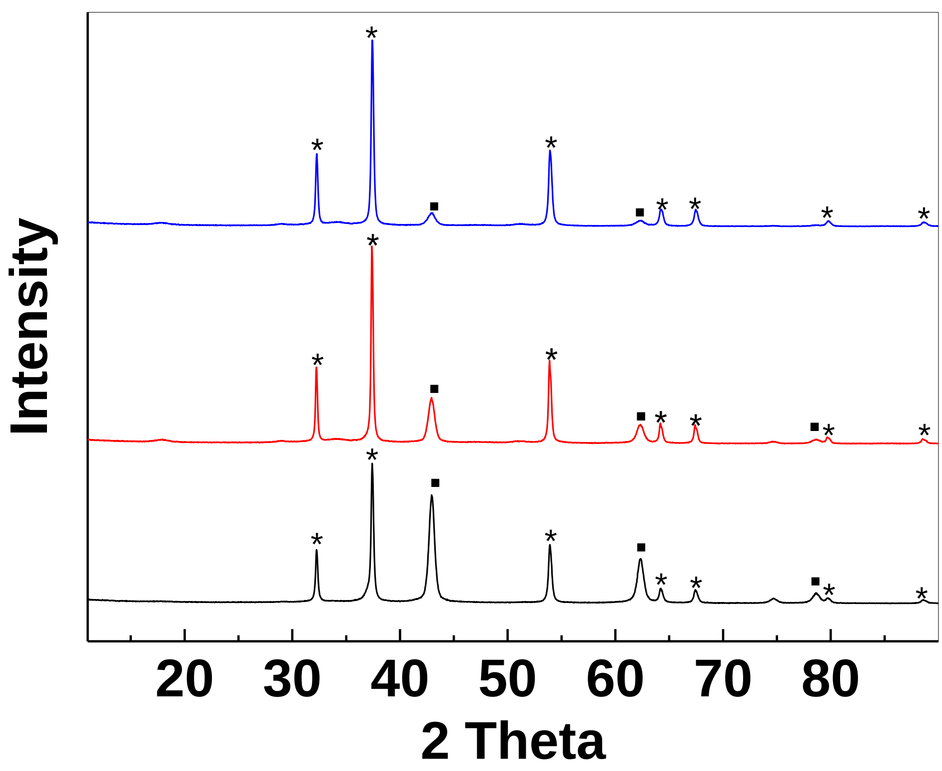


Figure S1. XRD after TGA of CMC-1(black), CMC-2(blue) and CMC-3 (red) MgO (■), CaO (*)

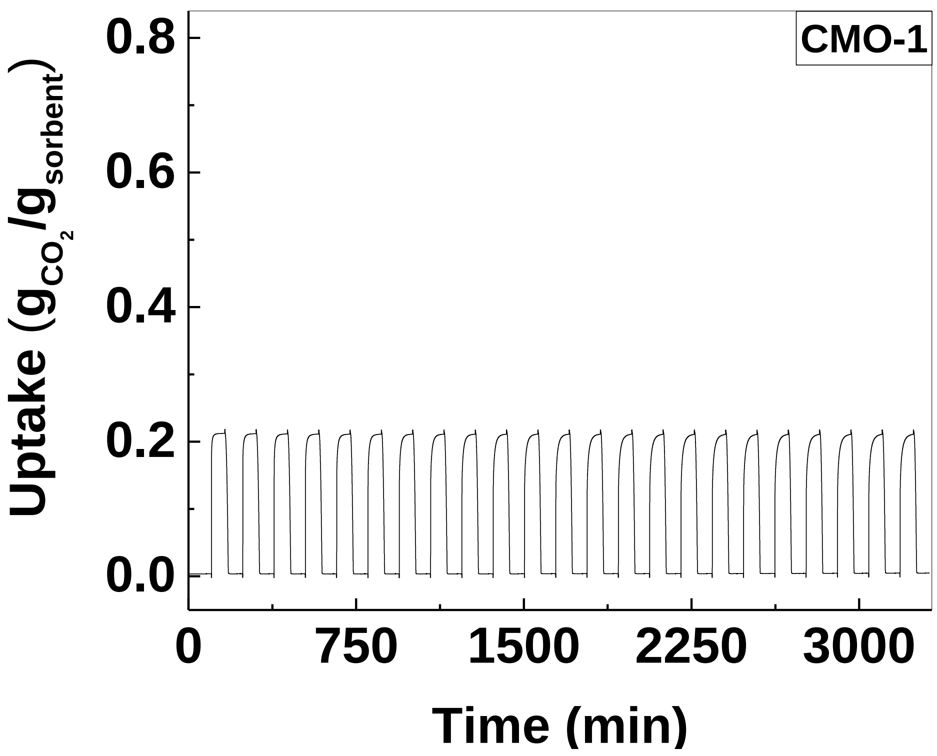


Figure S2. The CO_2 sorption cycles of CMO-1, from 1-23rd cycle

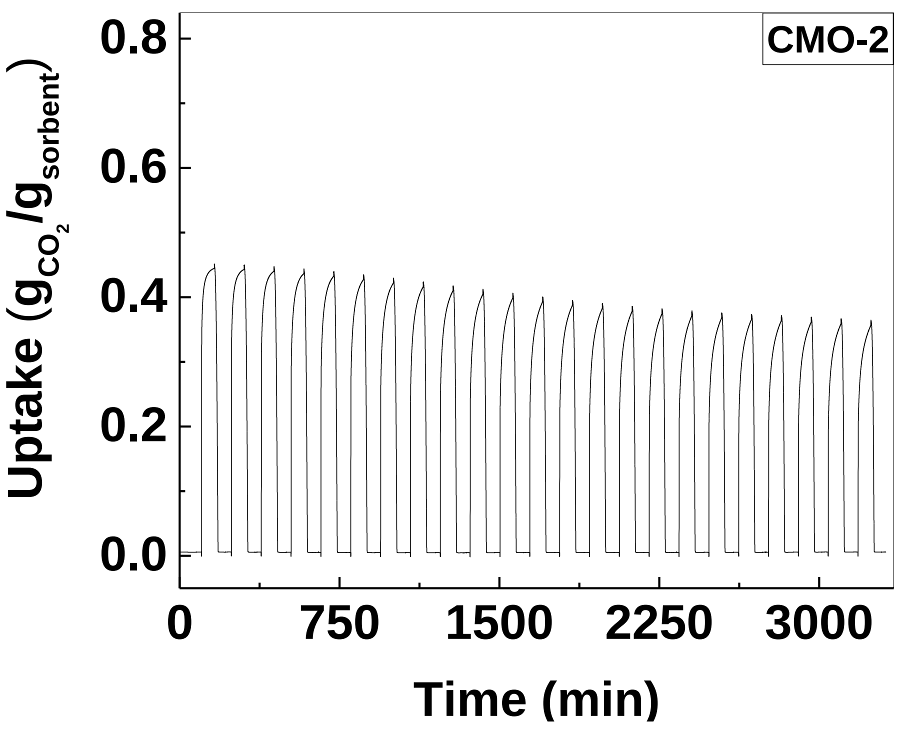


Figure S3. The CO_2 sorption cycles of CMO-2, from 1-23rd cycle

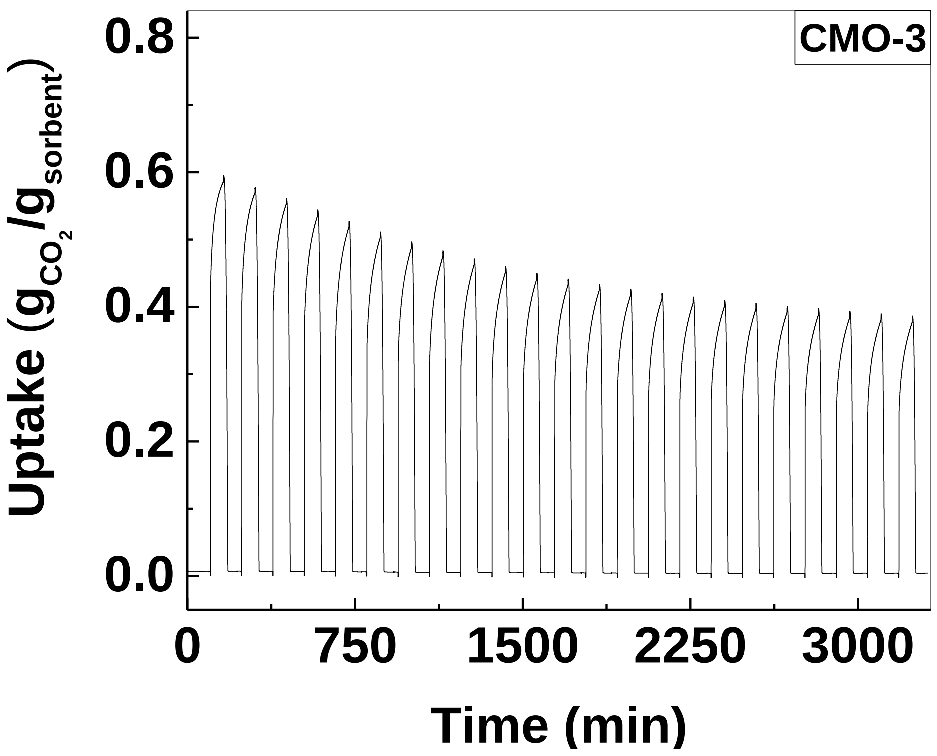


Figure S4. The CO_2 sorption cycles of CMO-3, from 1-23rd cycle

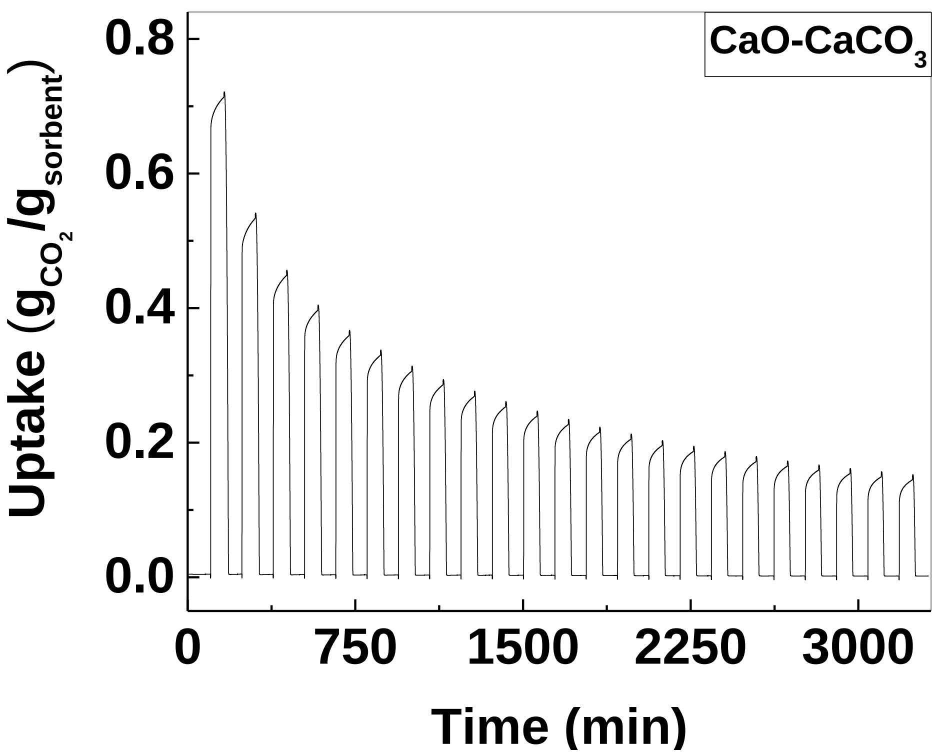


Figure S5. The CO_2 sorption cycles of CaO-$CaCO_3$, from 1-23rd cycle

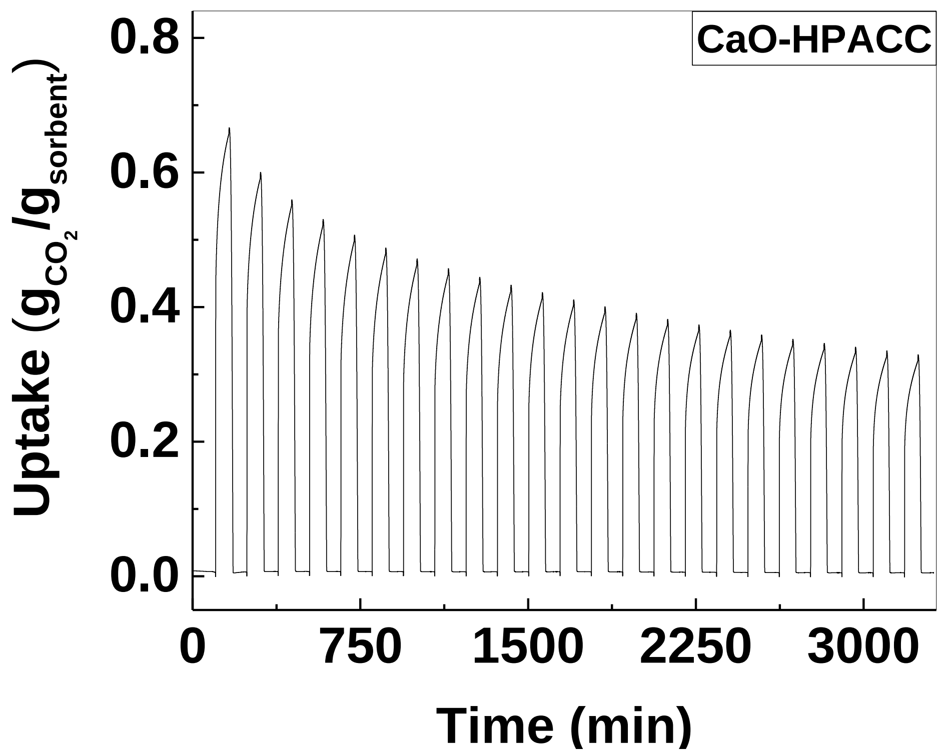


Figure S6. The CO_2 sorption cycles of CaO-HPACC, from 1-23rd cycle

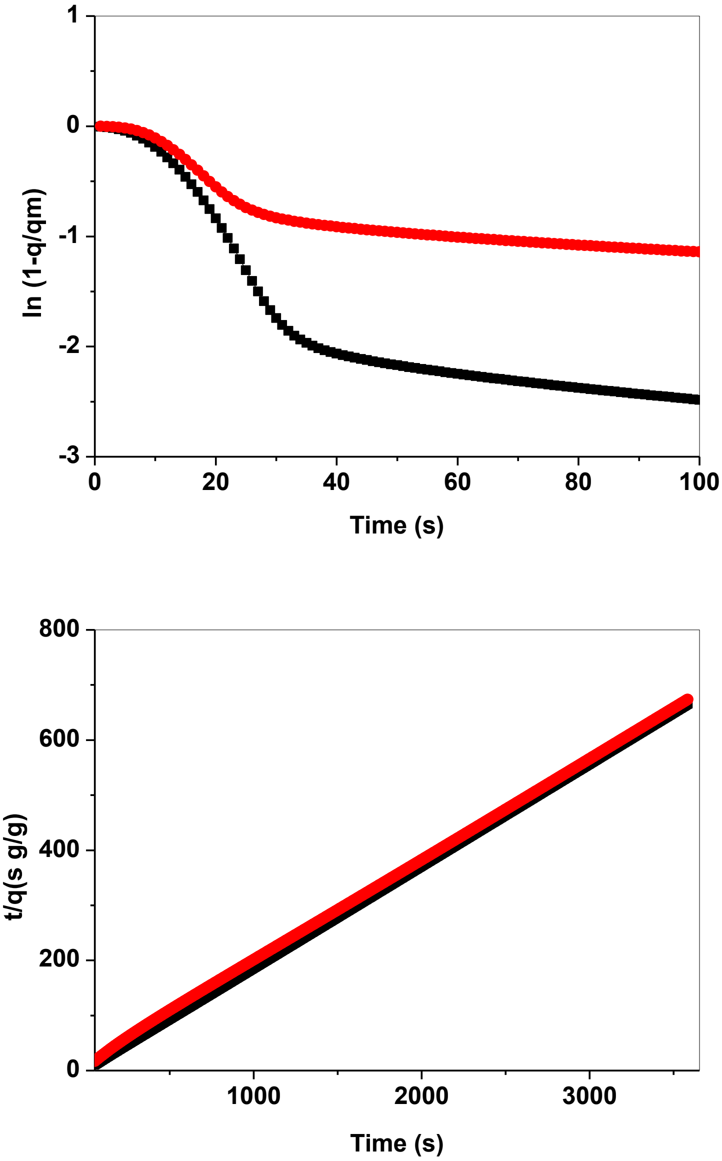
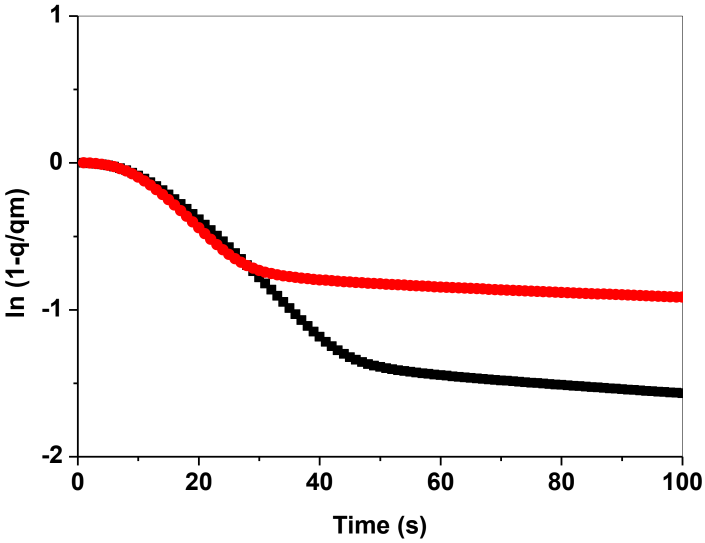


Figure S7. First (upper) and second (lower) order kinetic plot of CO_2 uptake on CMO-1 during the first (black) and 23[rd] cycle (red)



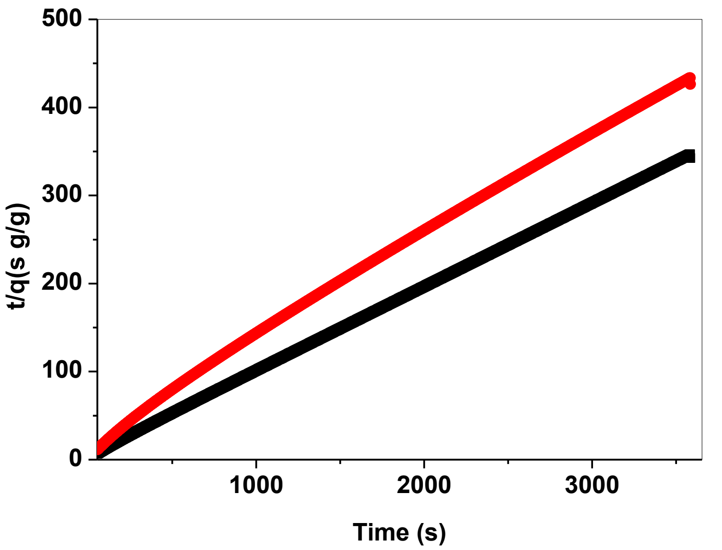


Figure S8. First (upper) and second (lower) order kinetic plot of CO_2 uptake on CMO-2 during the first (black) and 23rd cycle (red)

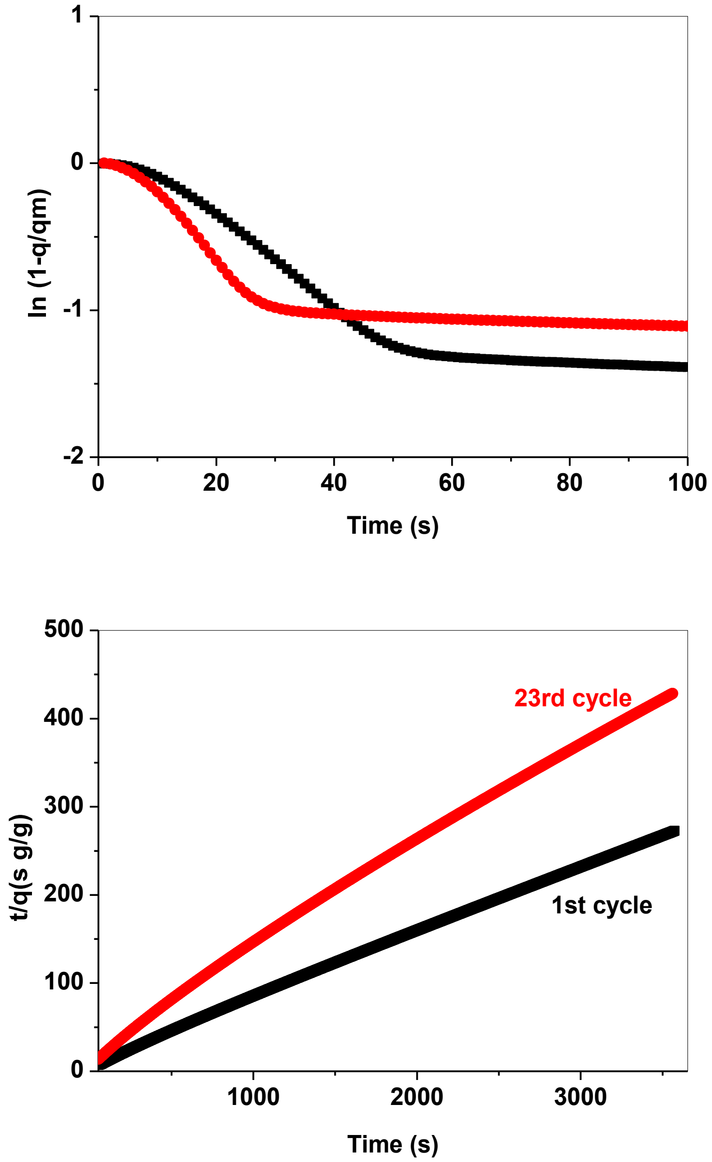


Figure S9. First (upper) and second (lower) order kinetic plot of CO_2 uptake on CMO-3 during the first (black) and 23rd cycle (red)

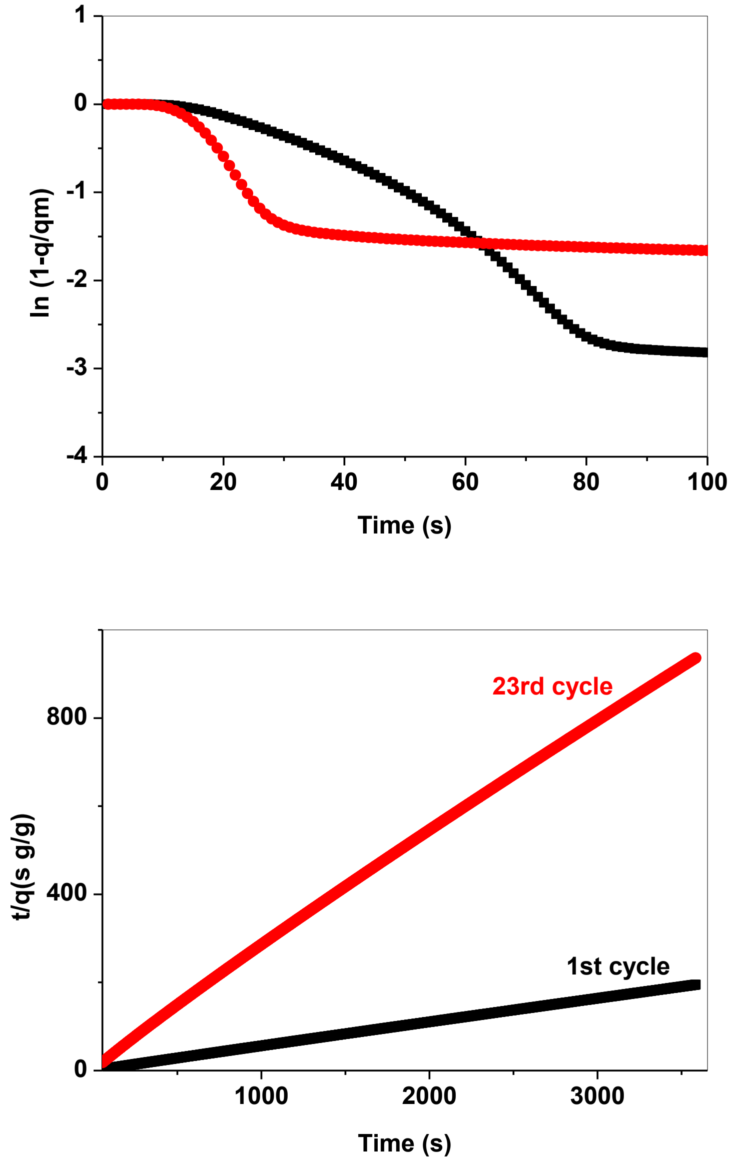


Figure S10. First (upper) and second (lower) order kinetic plot of CO_2 uptake on CaO-$CaCO_3$ during the first (black) and 23rd cycle (red)

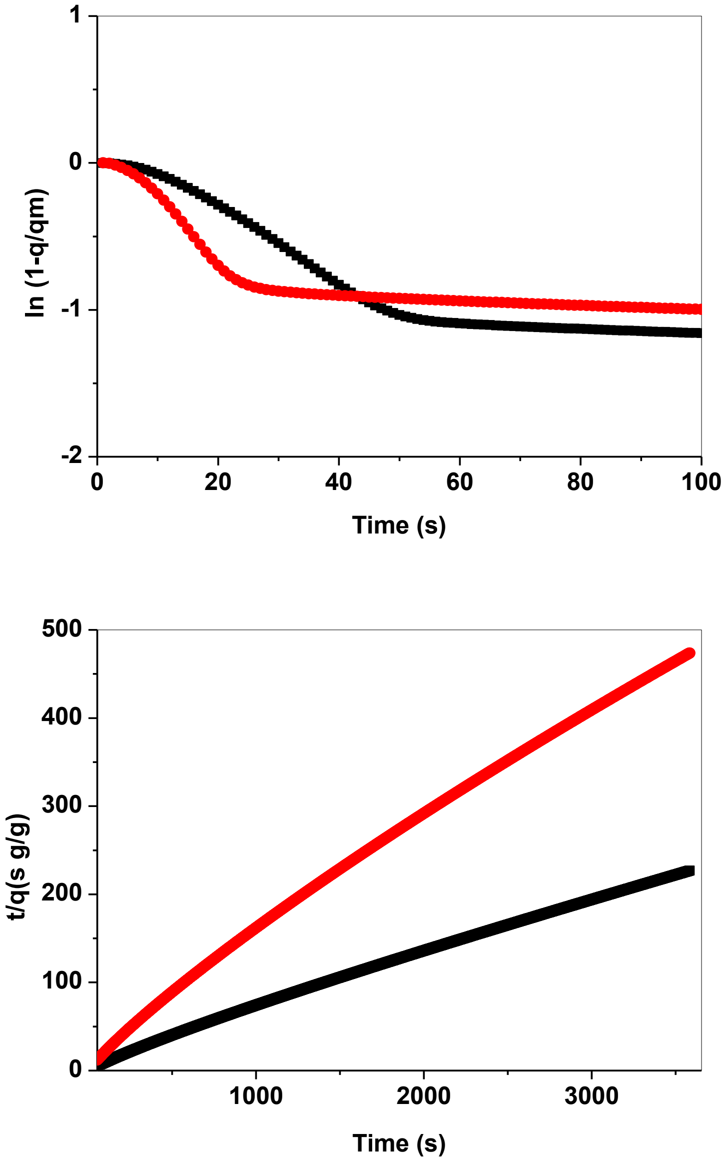


Figure S11. First (upper) and second (lower) order kinetic plot of CO_2 uptake on CaO-HPACC during the first (black) and 23rd cycle (red)

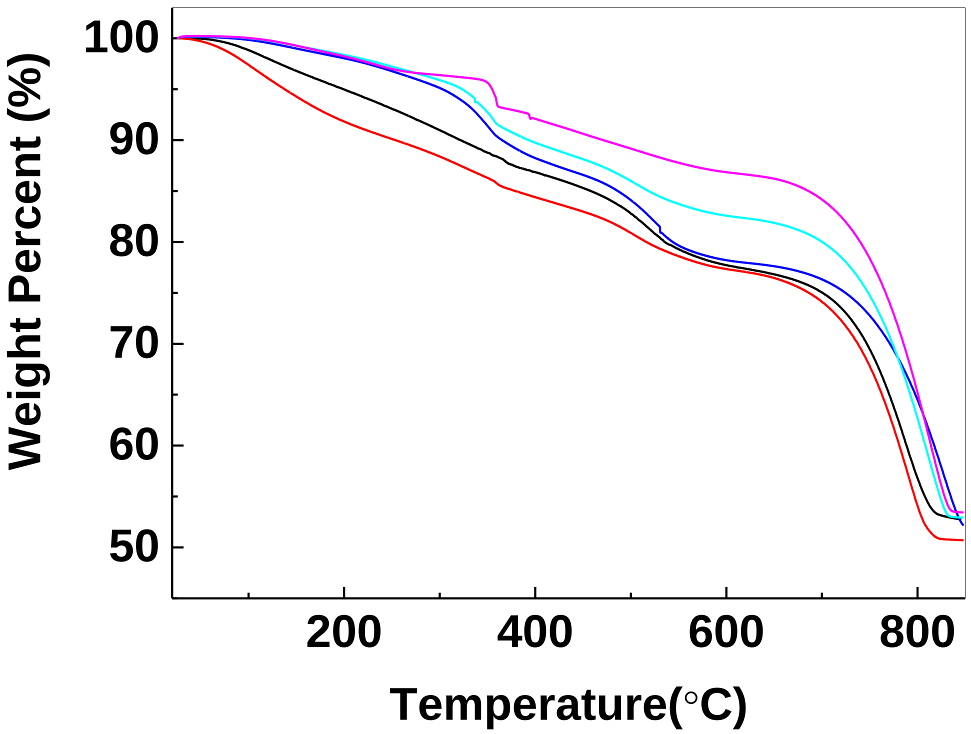


Figure S12. TGA curves of ACMO-1 (magenta), ACMO-2 (cyan), ACMO-3 (blue), ACMO-4 (red) and ACMO-5 (black)

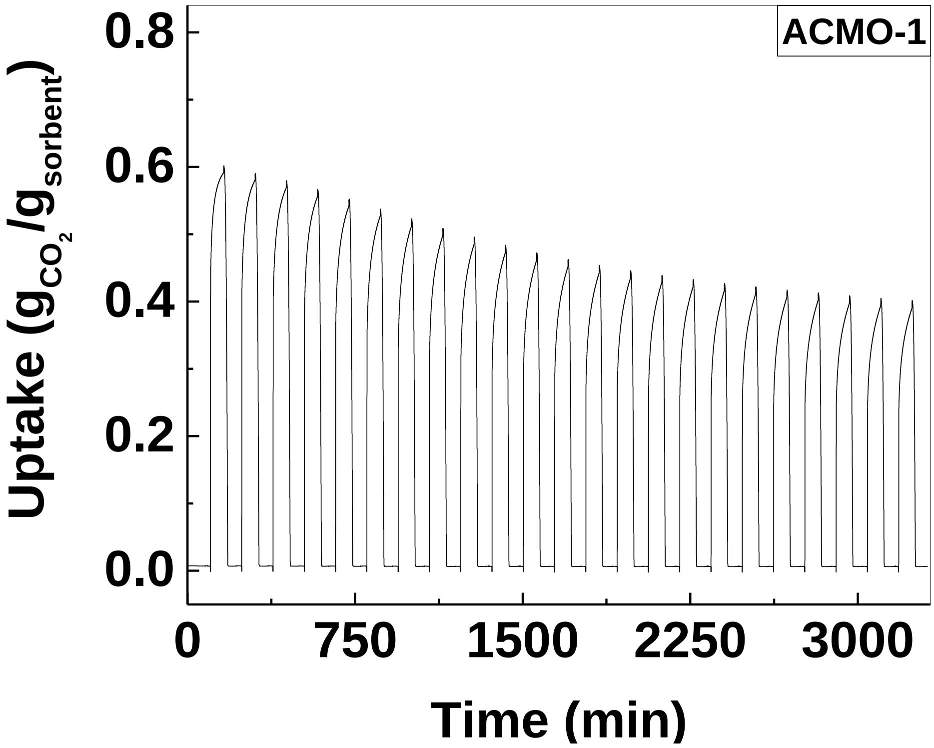


Figure S13. The CO_2 sorption cycles of ACMO-1, from 1 to 23rd cycle

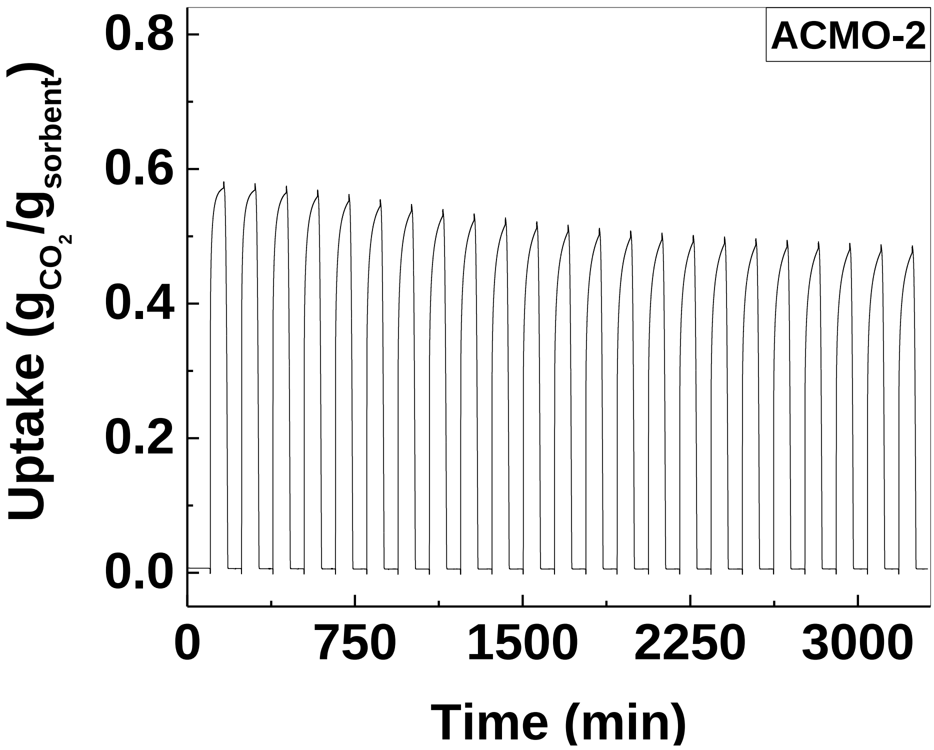


Figure S14. The CO_2 sorption cycles of ACMO-2, from 1 to 23rd cycle

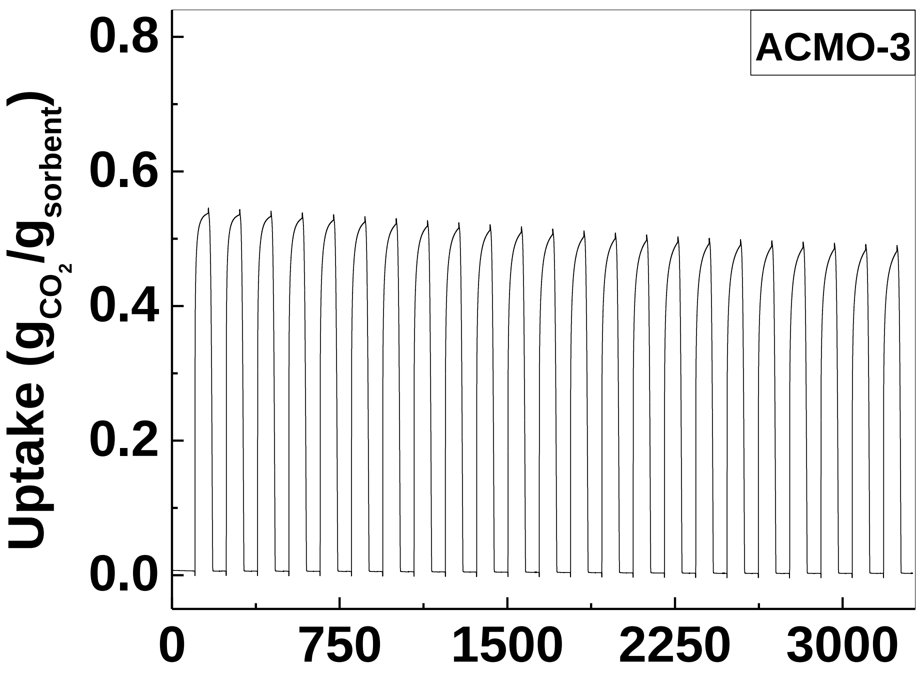


Figure S15. The CO_2 sorption cycles of ACMO-3, from 1 to 23rd cycle

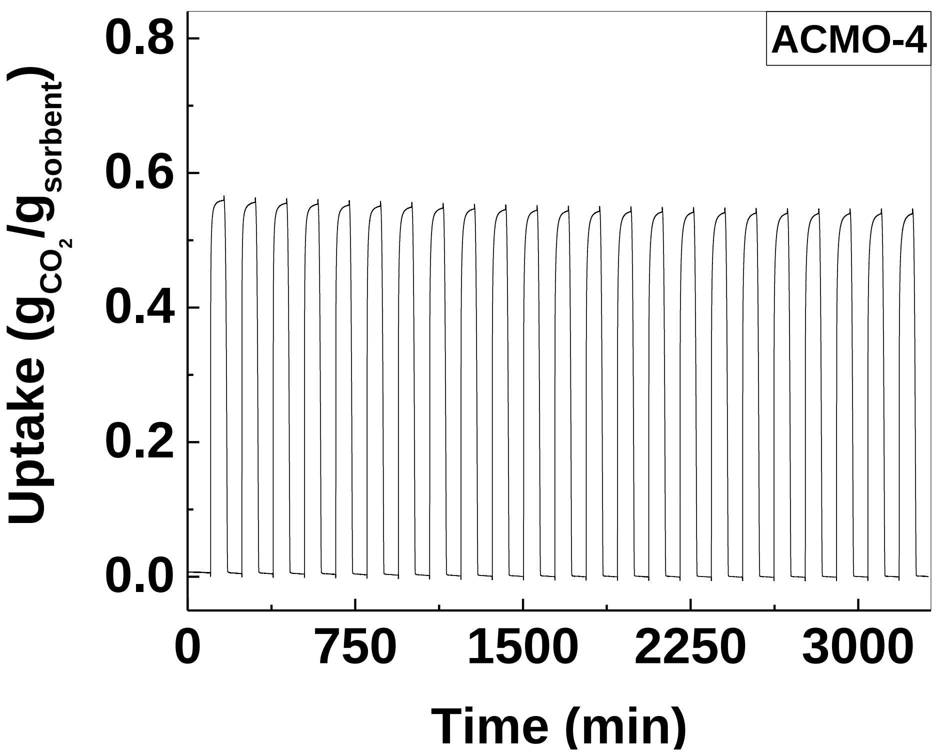


Figure S16. The CO_2 sorption cycles of ACMO-4, from 1 to 23rd cycle

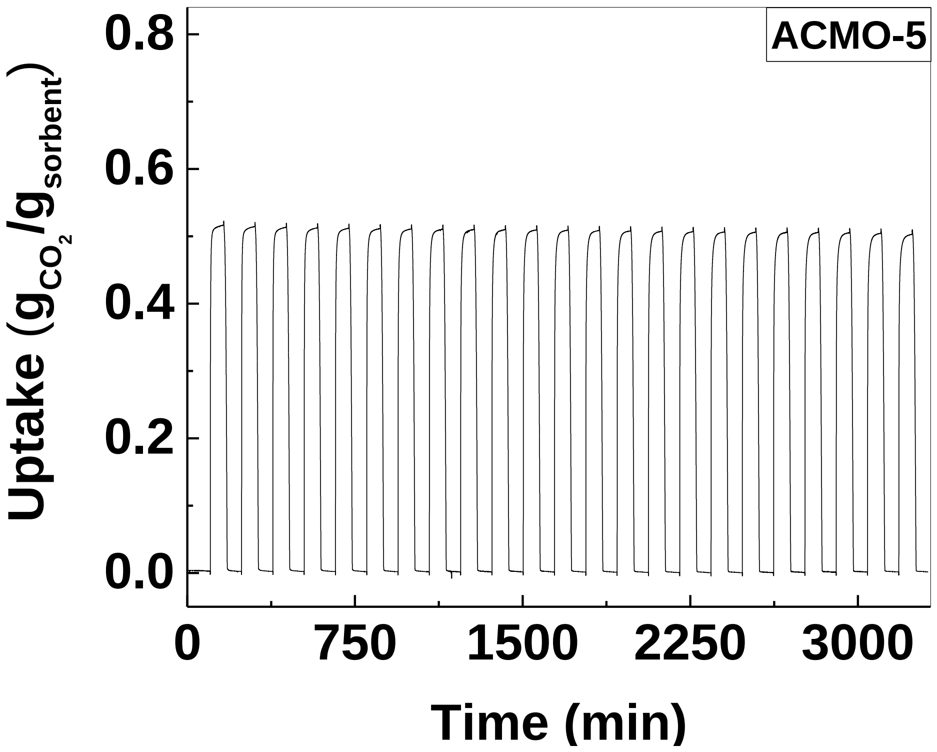
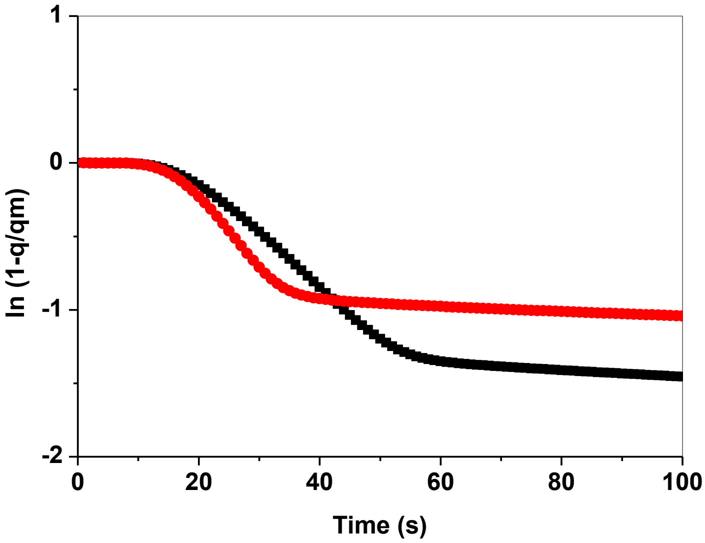


Figure S17. The CO_2 sorption cycles of ACMO-5, from 1 to 23rd cycle



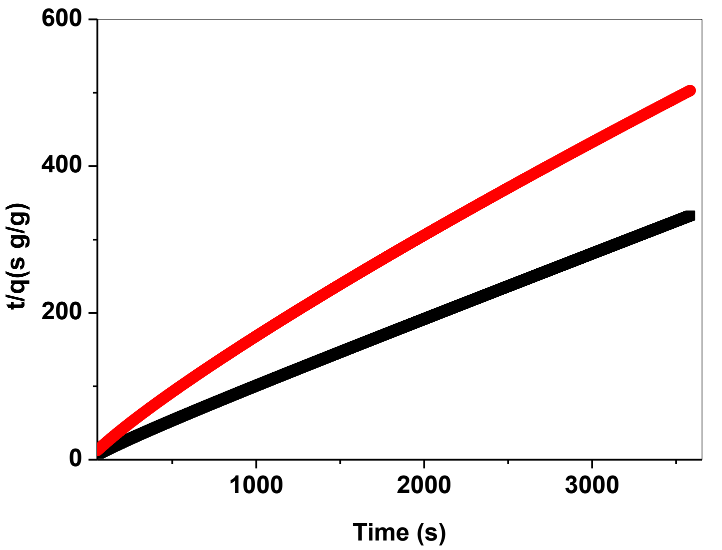


Figure S18. First (upper) and second (lower) order kinetic plot of CO_2 uptake on ACMO-1 during the first (black) and 23rd cycle (red)

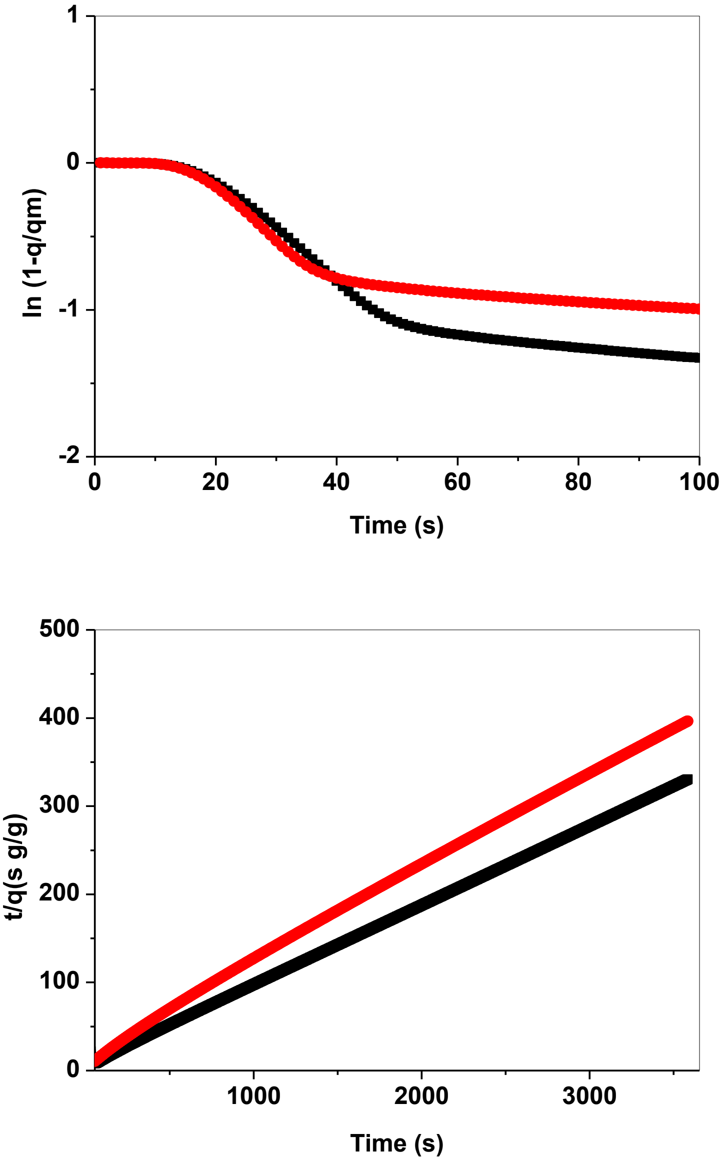


Figure S19. First (upper) and second (lower) order kinetic plot of CO_2 uptake on ACMO-1 during the first (black) and 23rd cycle (red)

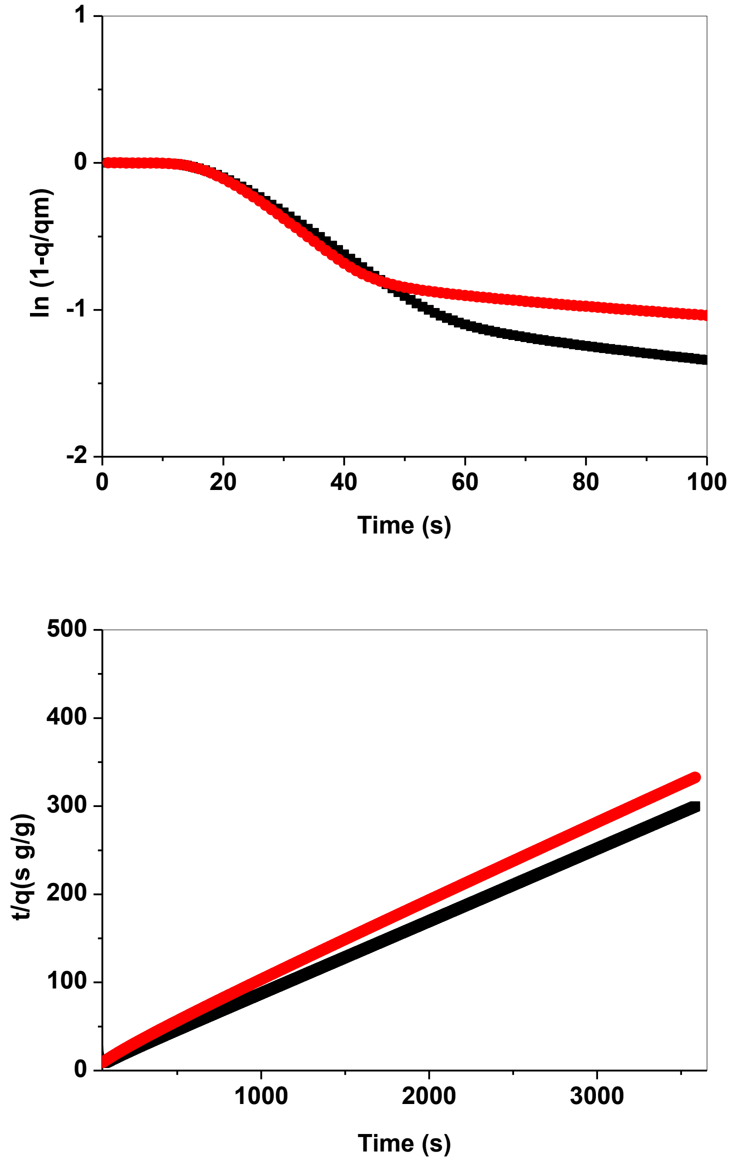
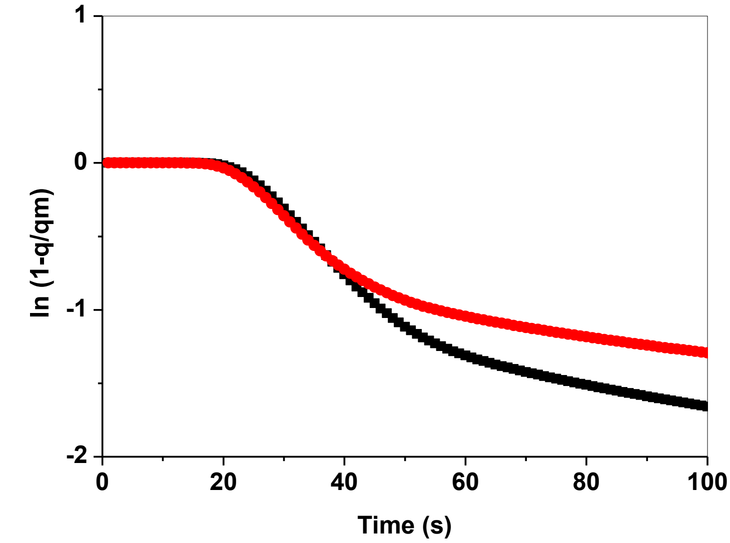


Figure S20. First (upper) and second (lower) order kinetic plot of CO_2 uptake on ACMO-3 during the first (black) and 23rd cycle (red)



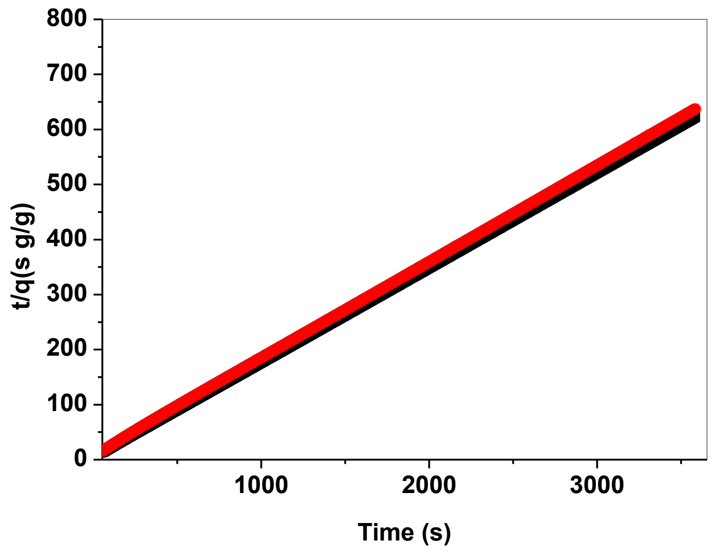


Figure S21. First (upper) and second (lower) order kinetic plot of CO_2 uptake on ACMO-4 during the first (black) and 23rd cycle (red)

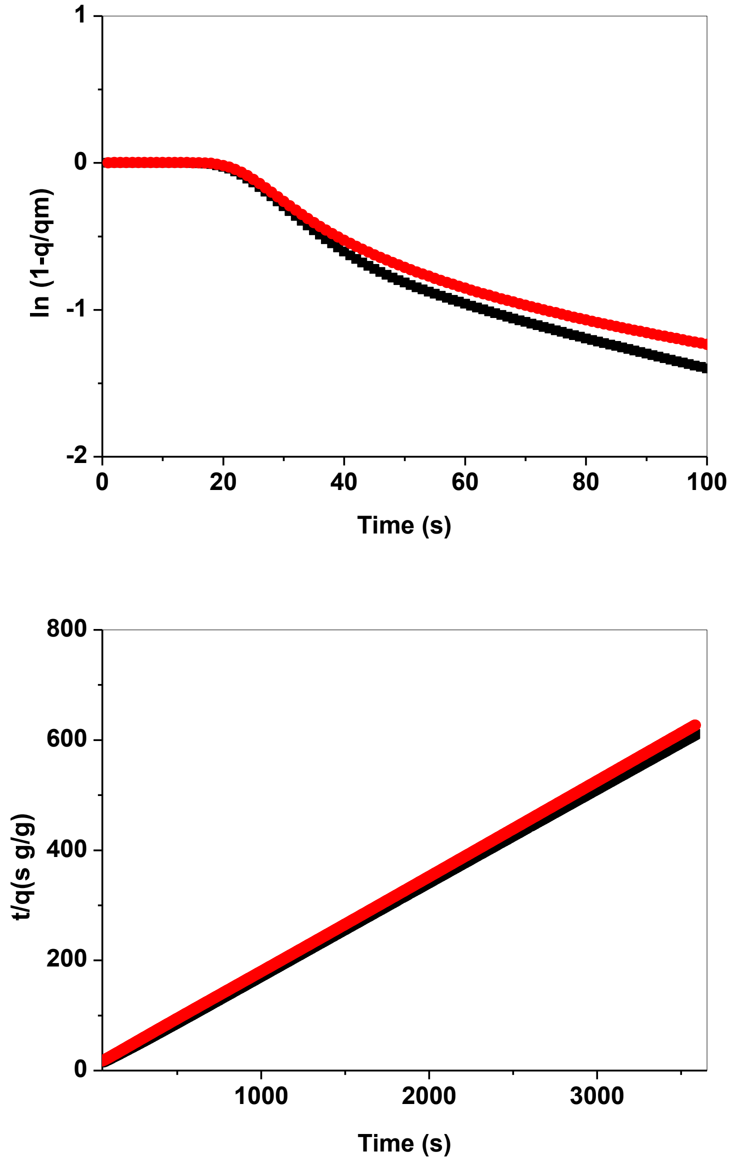


Figure S22. First (upper) and second (lower) order kinetic plot of CO_2 uptake on ACMO-5 during the first (black) and 23rd cycle (red)

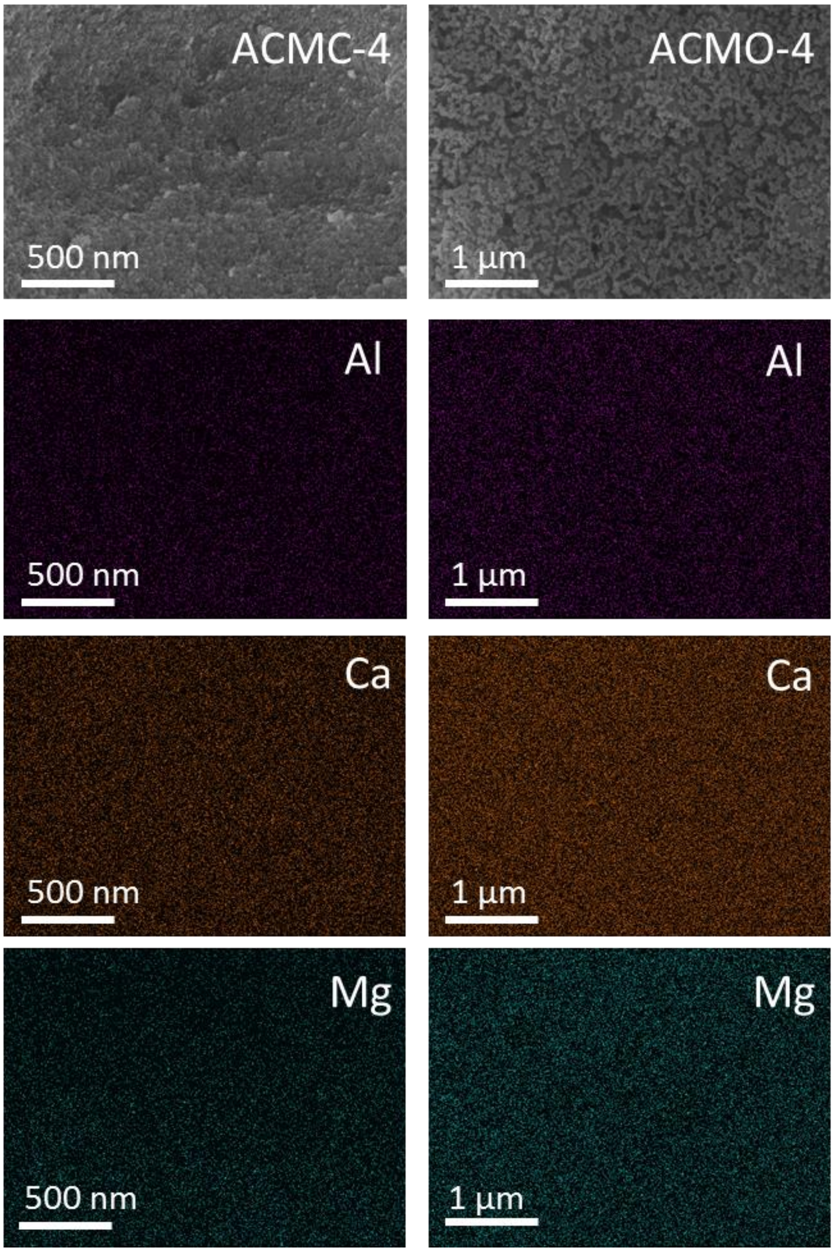


Figure S23. EDX mapping of the Al, Ca and Mg on ACMC-4 and ACMO-4

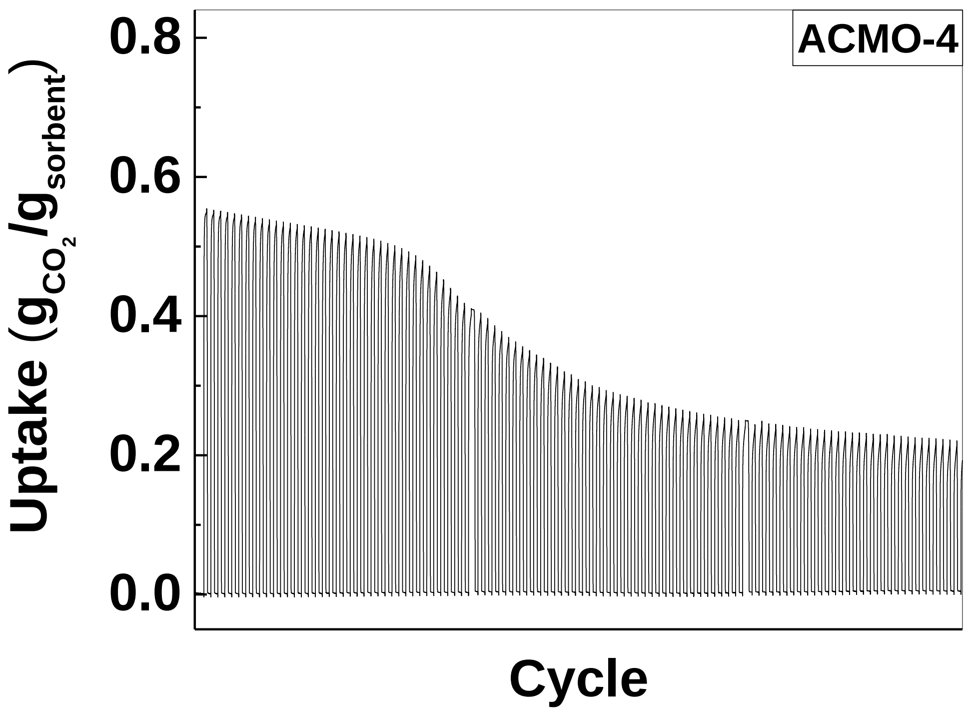


Figure S24. The CO_2 sorption cycles of ACMO-4, from 1 to 100th cycle

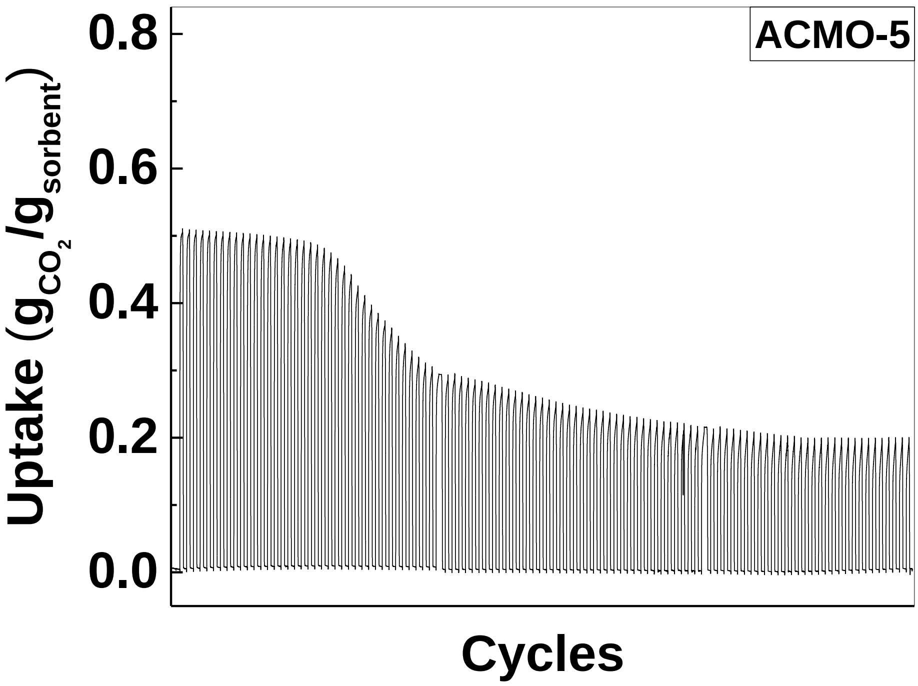


Figure S25. The CO_2 sorption cycles of ACMO-4, from 1 to 100th cycle

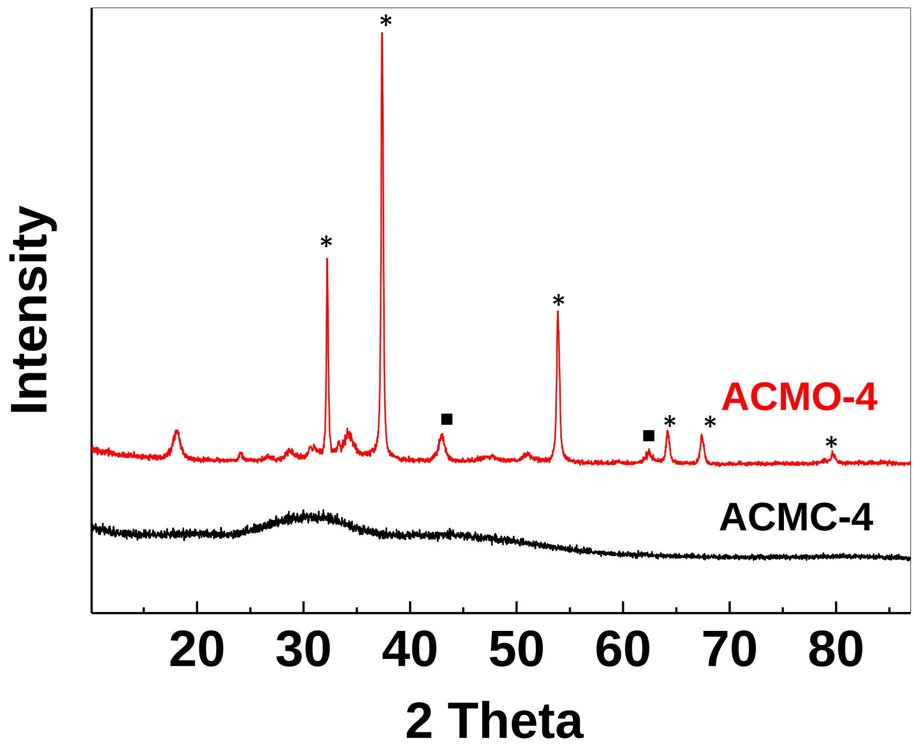


Figure S26. XRD before and after 100 adsorption cycles MgO (■), CaO (*)

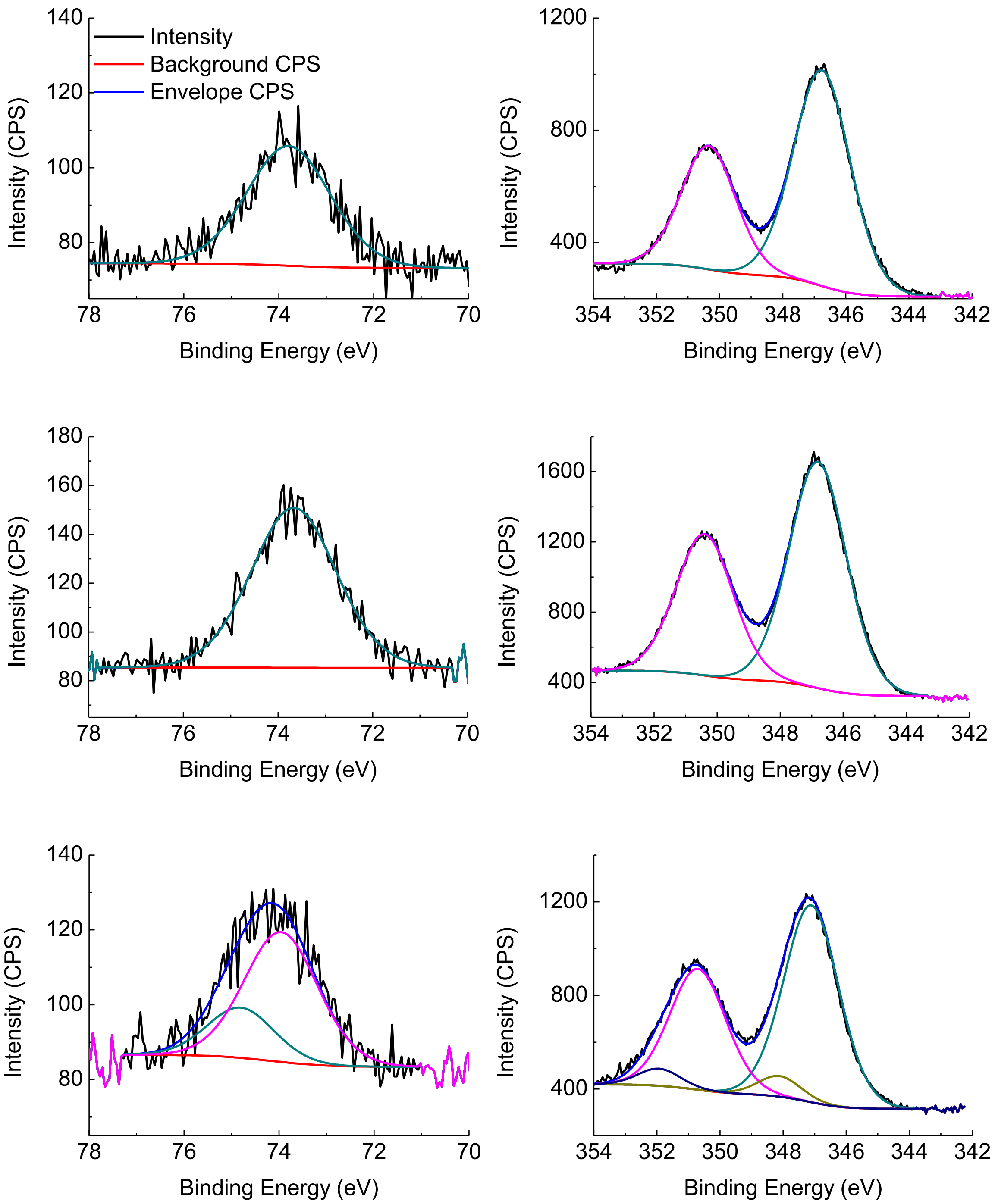


Figure S27. X-ray photoelectron spectra of a, b) ACMO-4 before CO_2 uptake experiments c,d) ACMO-4 after 23 cycles and e,f) ACMO-4 after 39 cycles, the Al 2p peak is shown in A,C and E, the Ca 2p peak is shown in B,D and F

The XPS spectra of ACMO-4 after 23 and 39 CO_2 cycles are shown in Figure 27a-b. The Al 2p spectra (Figure S27a) clearly demonstrated that only one type of Al existed on ACMO-4 before CO_2 sorption cycles. The changes in the Ca 2p and Al 2p peak after 23 and 39 cycles (Figure 27 c-f) indicated that the coordination around the Ca and Al had changed. New additional peaks could be fitted to the respective XPS spectra. This change corresponded to the partial formation of mayenite. The formation of a small amount of mayenite on ACMO-4 after ~30-40 CO_2 cycles was revealed by XRD and shown in Figure S26.

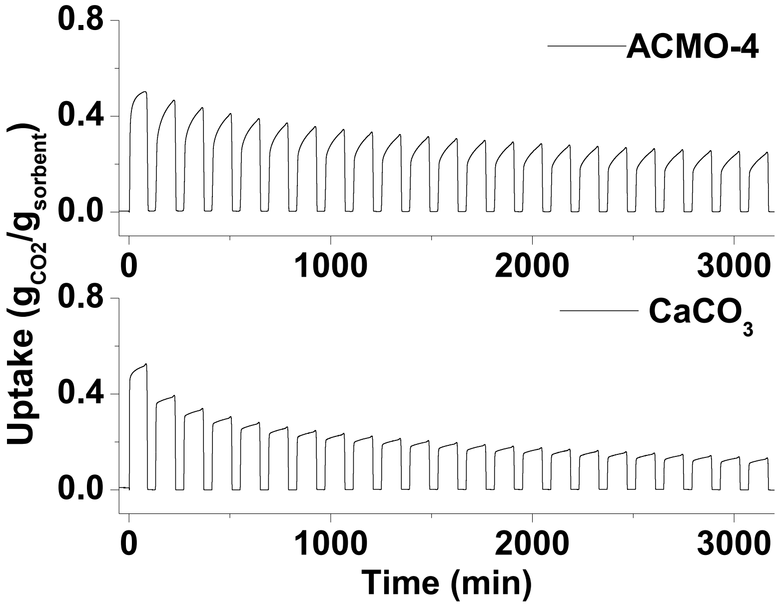


Figure S28. The CO_2 sorption cycles from a gas mixture (20% CO_2, 80% N_2) of ACMO-4 (top) and $CaCO_3$ (bottom), from 1 to 23rd cycle, the same gas mixture was used during CO_2 uptake at 650 °C and desorption at 850 °C

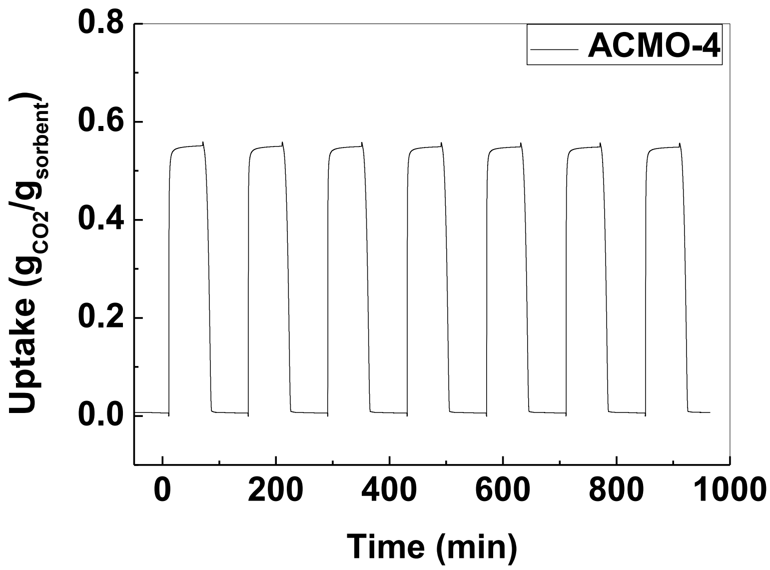


Figure S29. The CO_2 sorption cycles of ACMO-4, from 1 to 7th cycle where the CO_2 gas was mildly hydrated by bubbling through 5 water traps before being exposed to the ACMO-4 sorbent