Electronic Supplementary Material (ESI) for Nanoscale Advances.


*Supporting Information*

# Structural modification of salt-promoted MgO sorbents for intermediate temperature $CO_2$ capture

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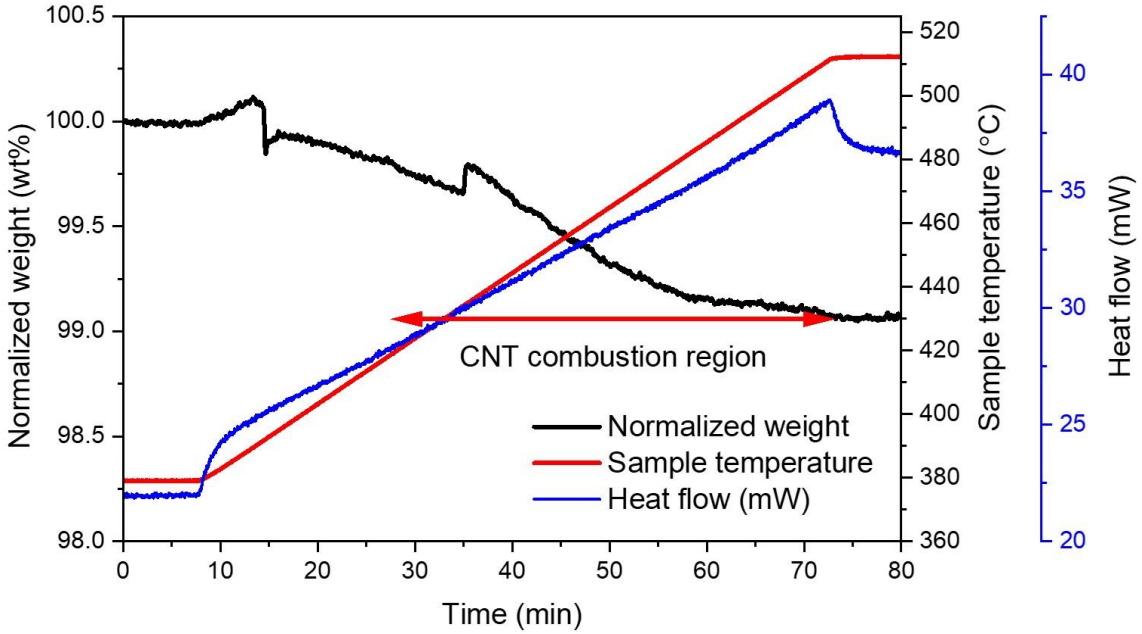
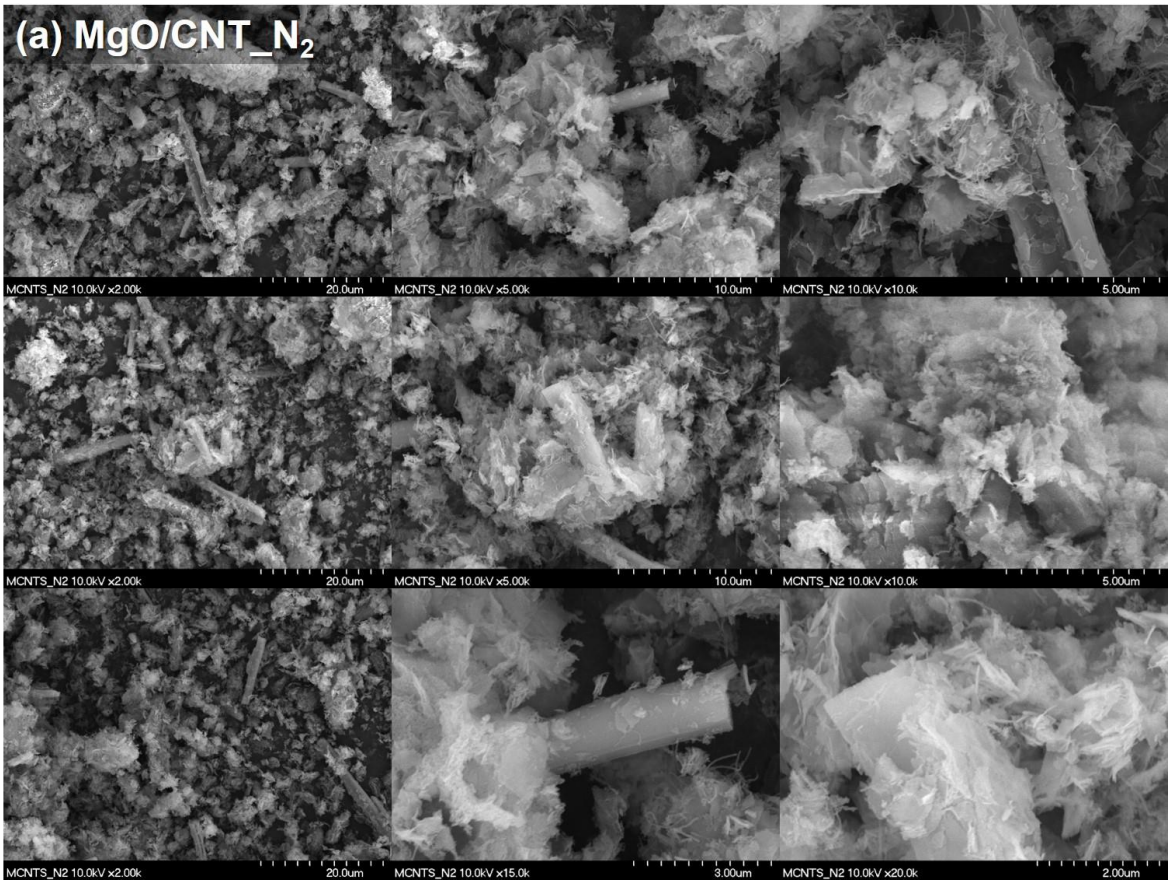
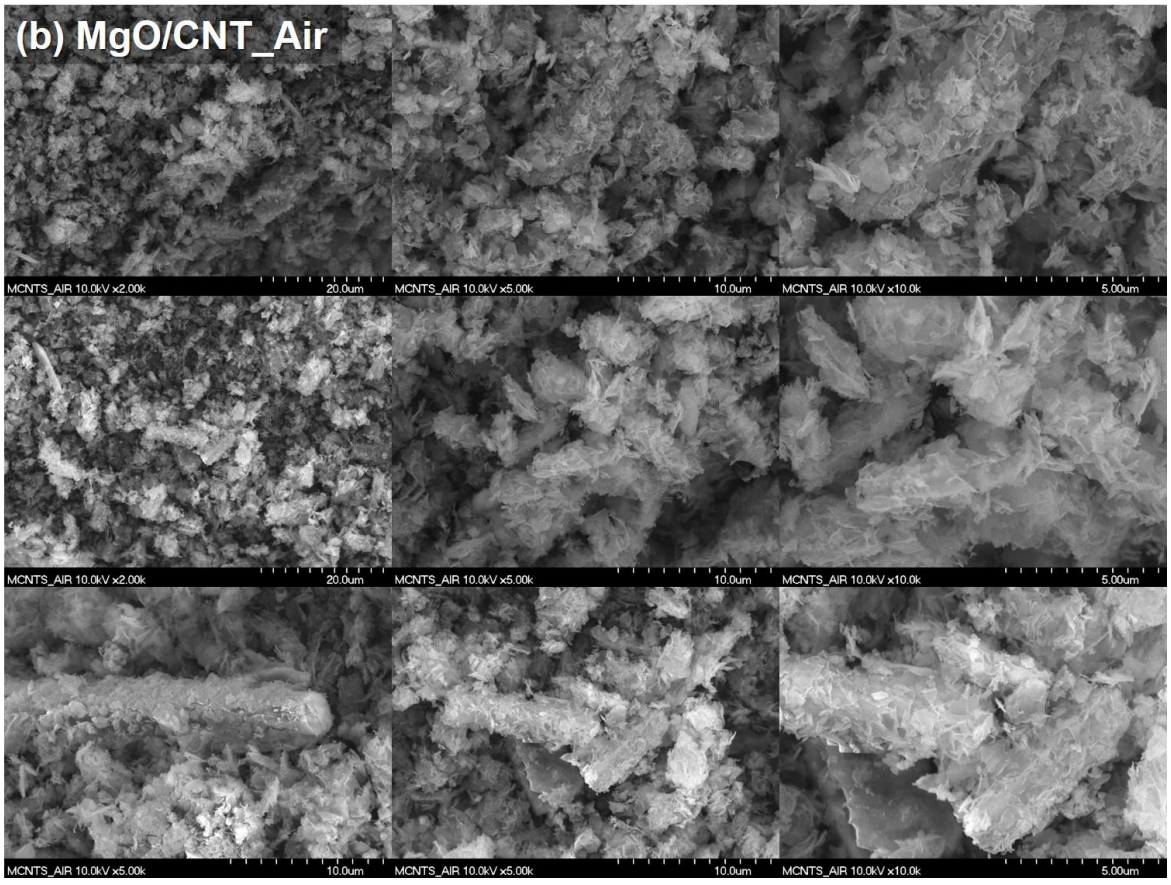


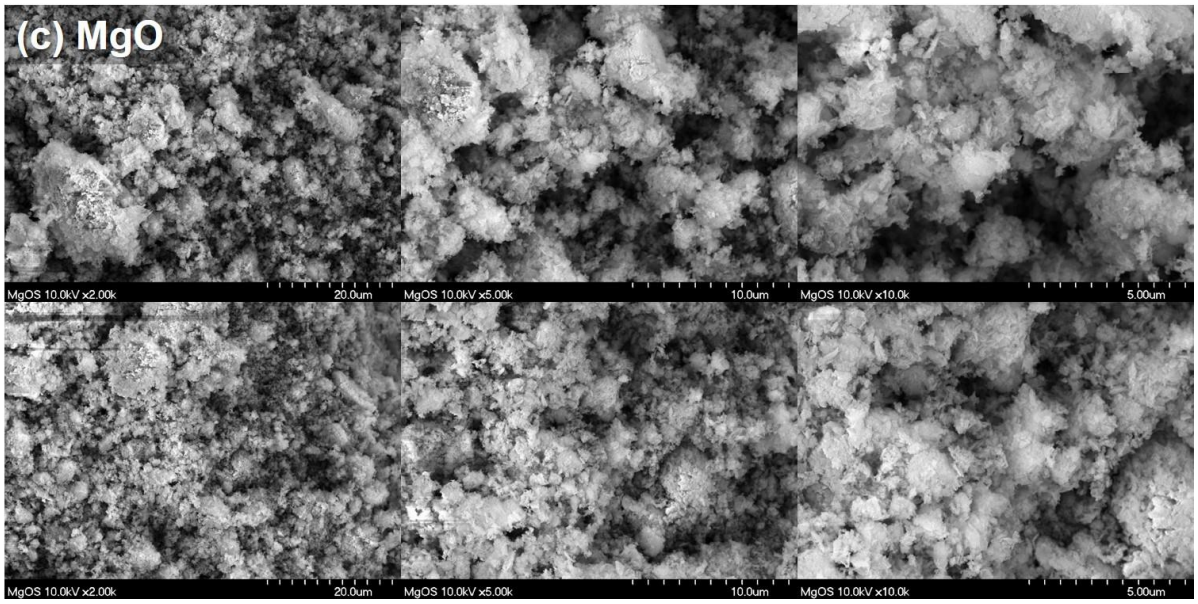

**Fig. S1**. Normalized weight profile of MgO/CNT_Air during combustion under air.

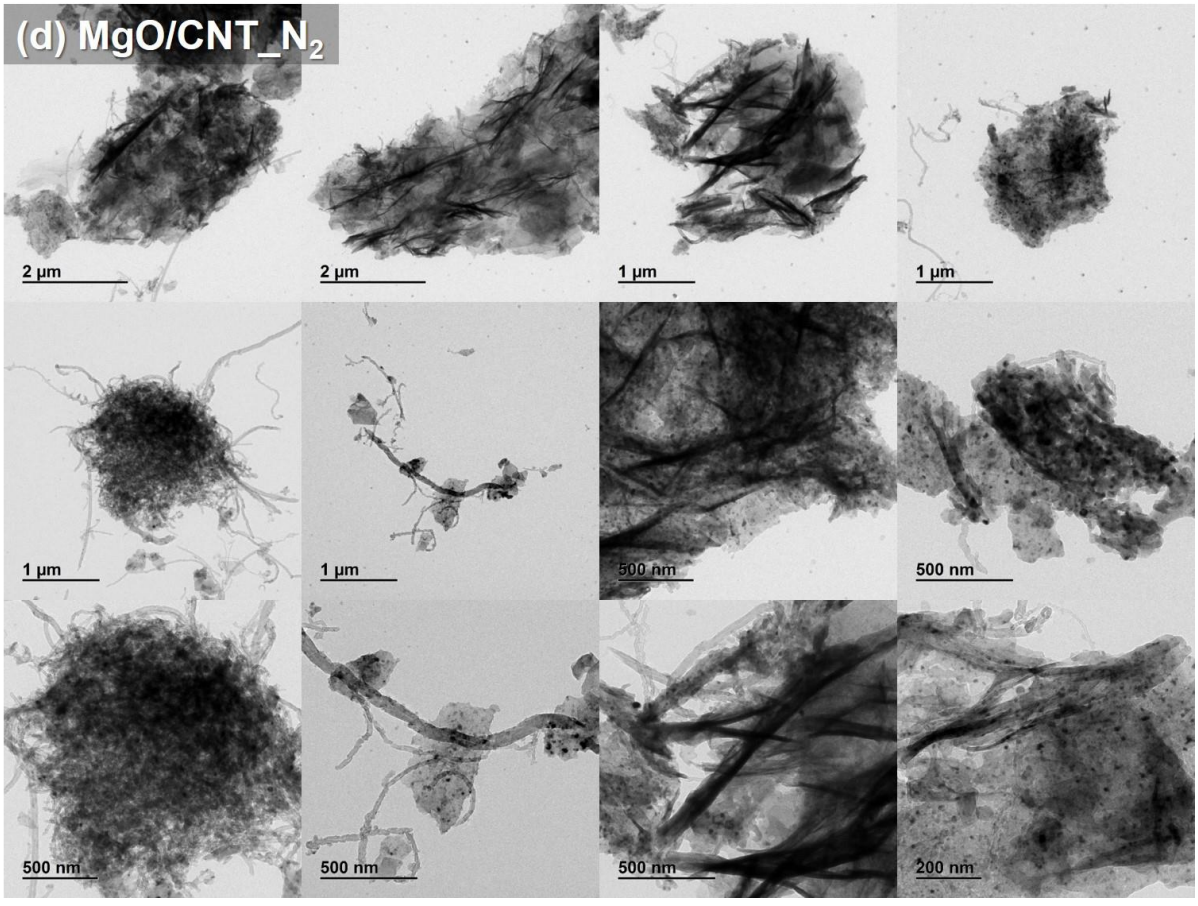
**Supplementary note 1.**

The combustion of CNT should be observed from 410 °C under the air atmosphere. MgO/CNT_Air sample had ~ 0.7 wt% of weight decrement and the heat flow of CNT combustion was not observed. In addition, the decomposition of alkali metal salt was observed in MgO/CNT_$N_2$ sample (in Fig. S5) when there is a residual CNT which was not observed with MgO/CNT_Air sample. Therefore, the decrement is suspected not to the decomposition of residual CNT and the residual CNT in MgO/CNT_Air is negligible.


(a) MgO/CNT_N2
MCNTS_N2 10.0kV x2.00k 20.0um
MCNTS_N2 10.0kV x5.00k 10.0um
MCNTS_N2 10.0kV x10.0k 5.00um
MCNTS_N2 10.0kV x2.00k 20.0um
MCNTS_N2 10.0kV x5.00k 10.0um
MCNTS_N2 10.0kV x10.0k 5.00um
MCNTS_N2 10.0kV x2.00k 20.0um
MCNTS_N2 10.0kV x15.0k 3.00um
MCNTS_N2 10.0kV x20.0k 2.00um


(b) MgO/CNT_Air
MCNTS_AIR 10.0kV x2.00k 20.0um
MCNTS_AIR 10.0kV x5.00k 10.0um
MCNTS_AIR 10.0kV x10.0k 5.00um
MCNTS_AIR 10.0kV x2.00k 20.0um
MCNTS_AIR 10.0kV x5.00k 10.0um
MCNTS_AIR 10.0kV x10.0k 5.00um
MCNTS_AIR 10.0kV x5.00k 10.0um
MCNTS_AIR 10.0kV x5.00k 10.0um
MCNTS_AIR 10.0kV x10.0k 5.00um


(c) MgO
MgOS 10.0kV x2.00k
20.0um
MgOS 10.0kV x5.00k
10.0um
MgOS 10.0kV x10.0k
5.00um
MgOS 10.0kV x2.00k
20.0um
MgOS 10.0kV x5.00k
10.0um
MgOS 10.0kV x10.0k
5.00um


(d) MgO/CNT_N2
2 µm
2 µm
1 µm
1 µm
1 µm
1 µm
500 nm
500 nm
500 nm
500 nm
500 nm
200 nm

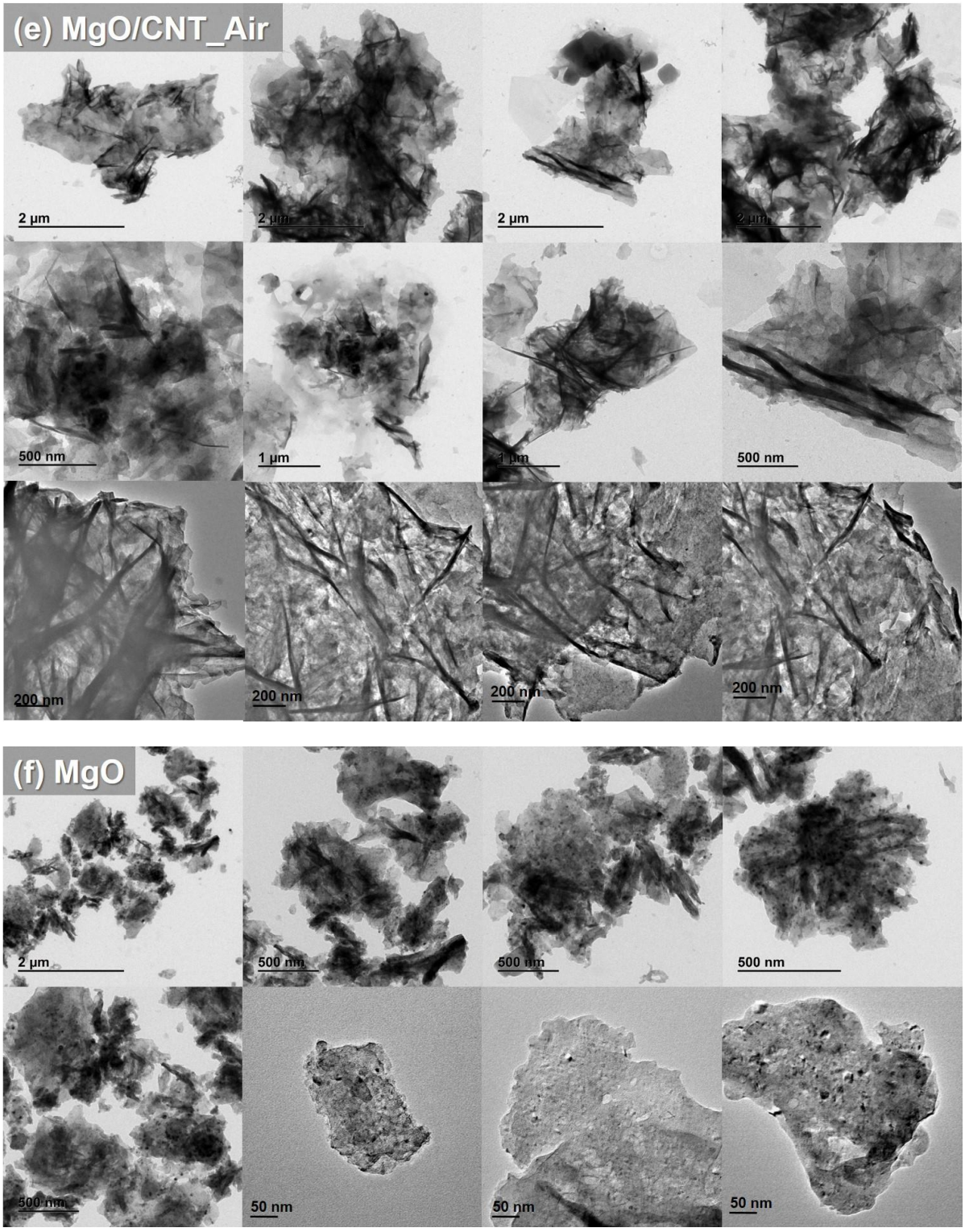
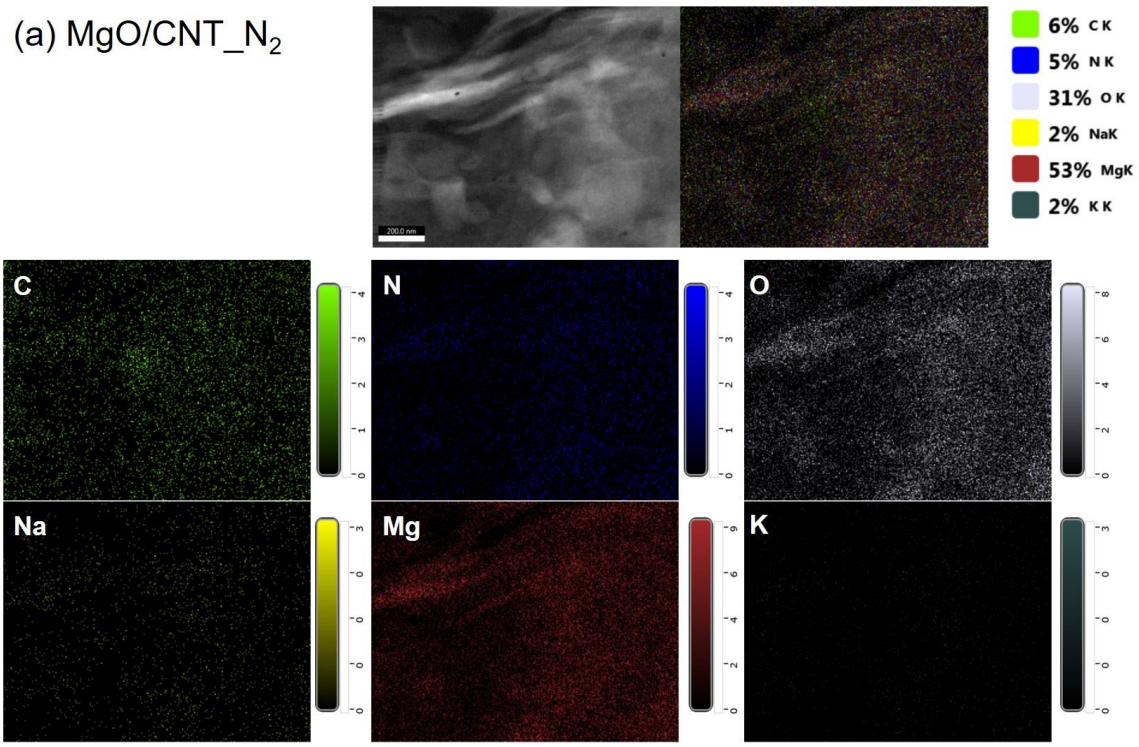
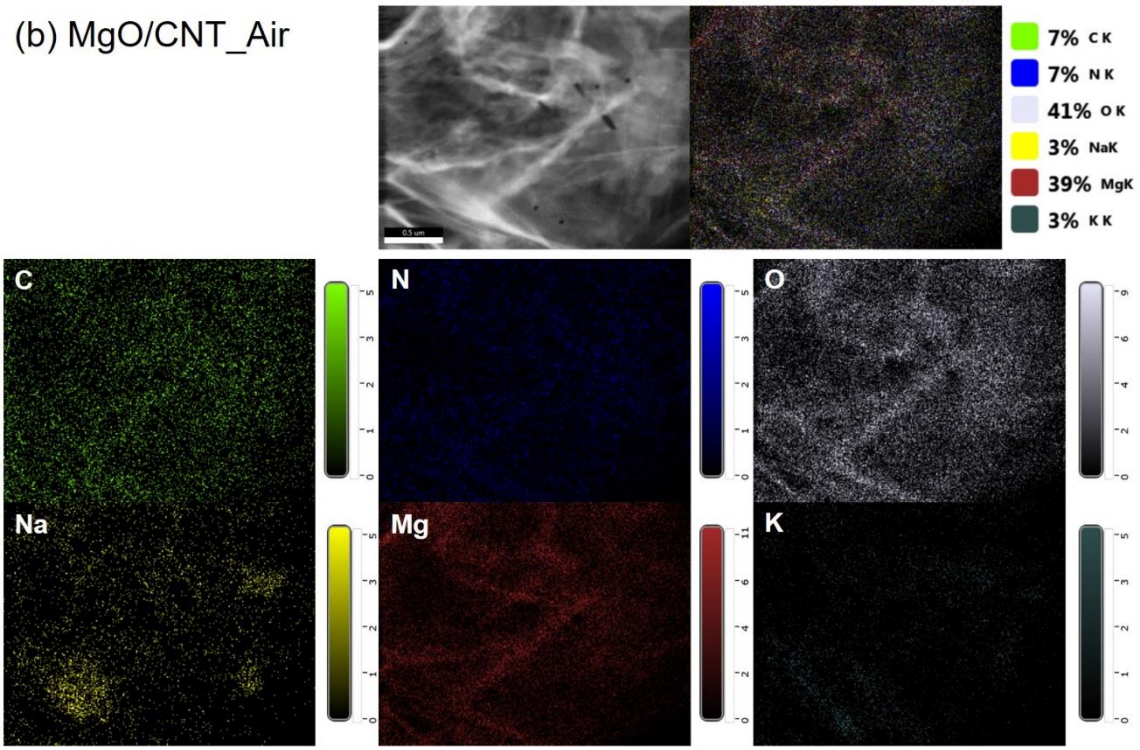



**Fig. S2**. SEM and TEM images of pristine MgO sorbents. SEM images of (a) MgO/CNT_$N_2$, (b) MgO/CNT_Air, (c) MgO, and TEM images of (d) MgO/CNT_N2, (e) MgO/CNT_Air, and (f) MgO.


(a) MgO/CNT_N2
6% C K
5% N K
31% O K
2% NaK
53% MgK
2% K K
C
N
O
Na
Mg
K


(b) MgO/CNT_Air
7% C K
7% N K
41% O K
3% NaK
39% MgK
3% K K
C
N
O
Na
Mg
K

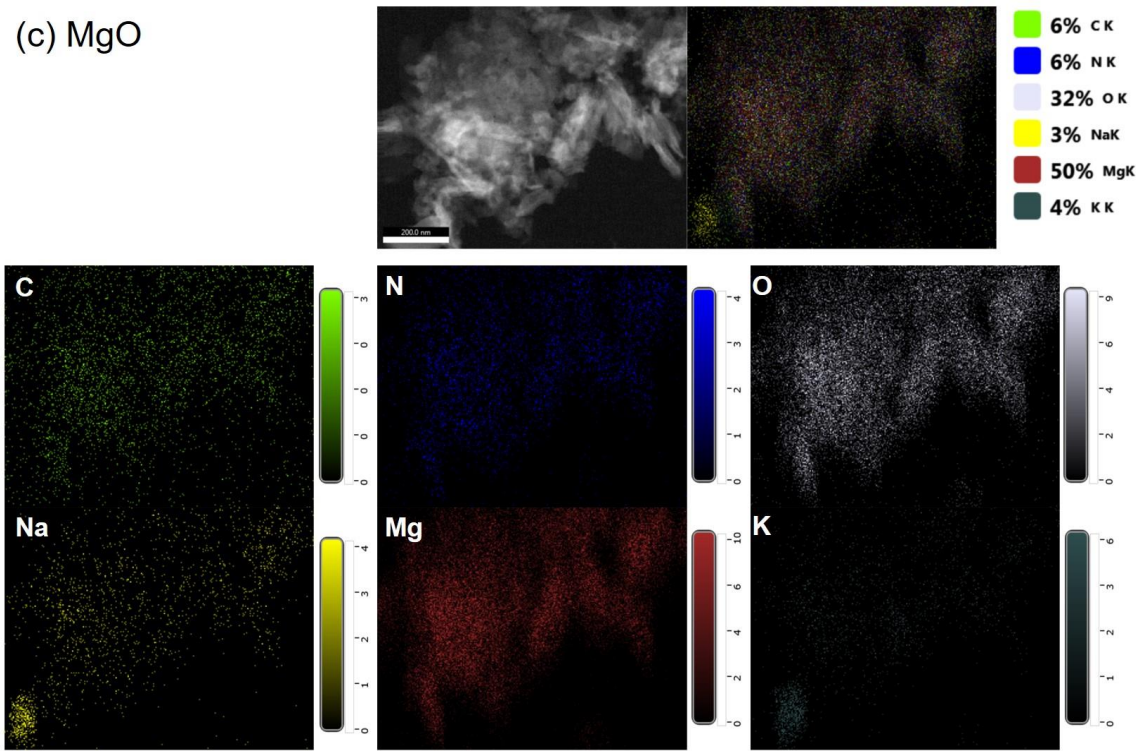



**Fig. S3**. TEM-EDX images and mapping data of MgO-based sorbents: (a) MgO/CNT_$N_2$, (b) MgO/CNT_Air, and (c) MgO

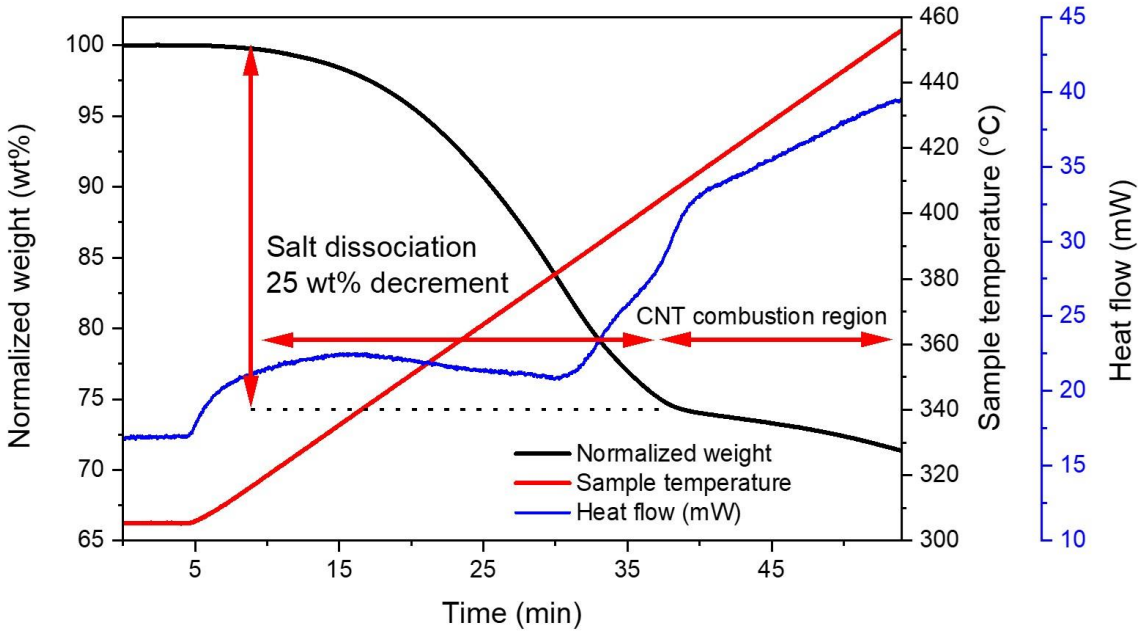



**Fig. S4.** Normalized weight profile of MgO/CNT_$N_2$ during combustion under air.

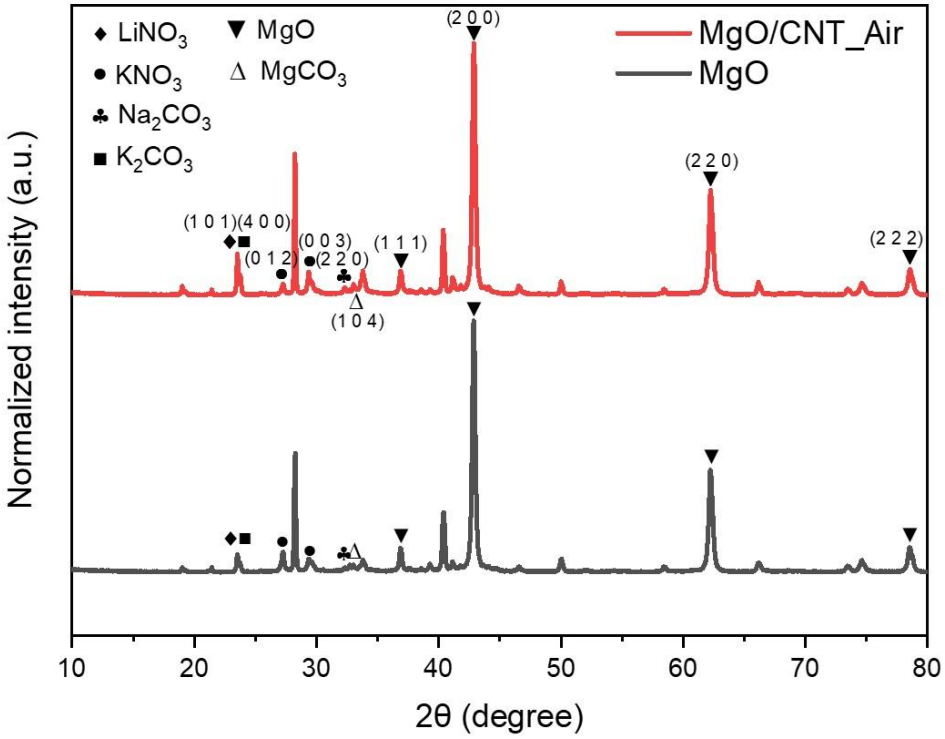



**Fig. S5.** XRD patterns of MgO/CNT_Air and MgO after one carbonation-calcination reaction.

**Supplementary Note 2.**

MgO peaks had high intensity, and a small $MgCO_3$ peak was observed. Preservation of the AMS after reactions was confirmed by observed AMS ($LiNO_3$, $KNO_3$, $Na_2CO_3$, $K_2CO_3$) peaks. XRD patterns of both samples was not significantly different, which support that the chemical composition of two sample was identical through reactions. The crystallite sizes were calculated using the Scherrer equation. The crystallite sizes of MgO/CNT_Air and MgO were 25.00 nm and 25.06 nm, respectively. It supports that the morphological difference caused effects of structural modification.

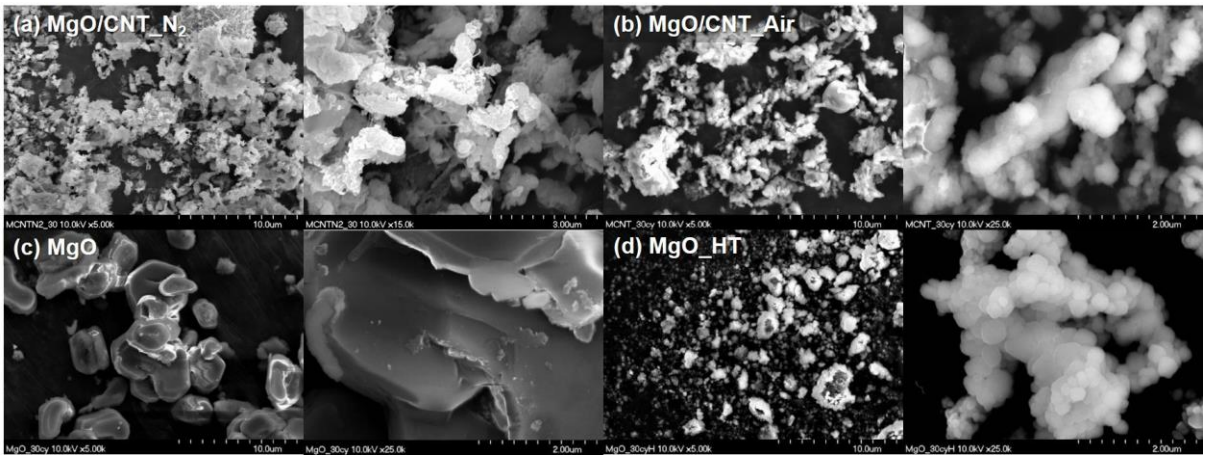
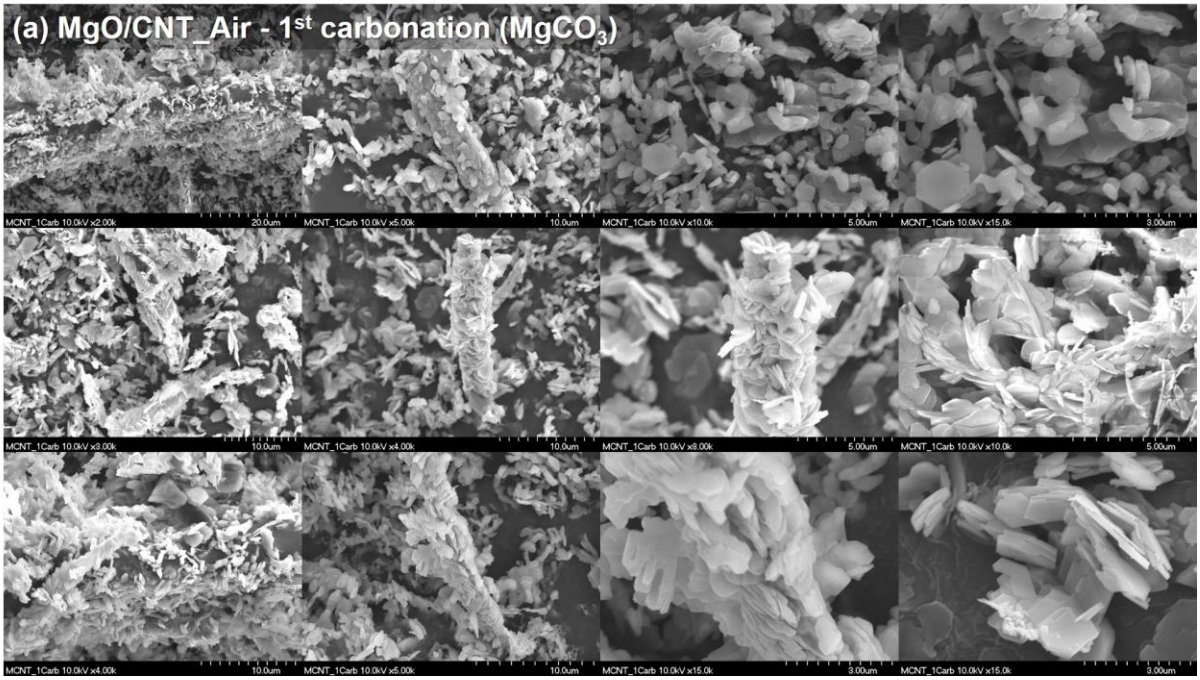
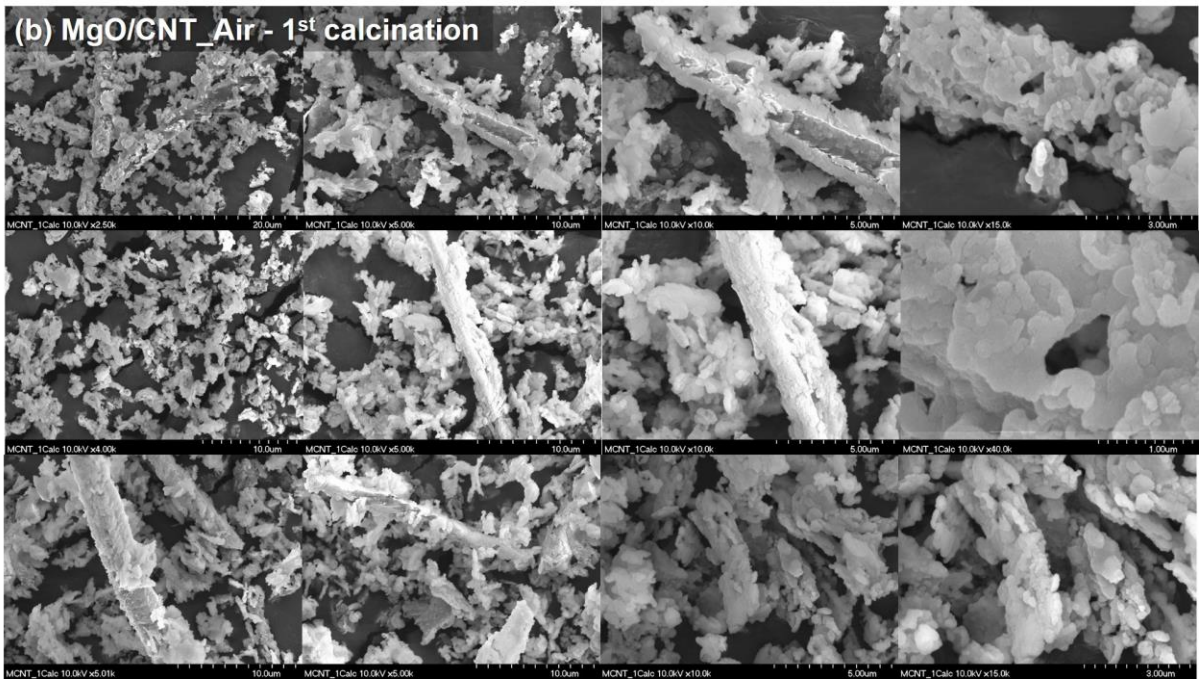
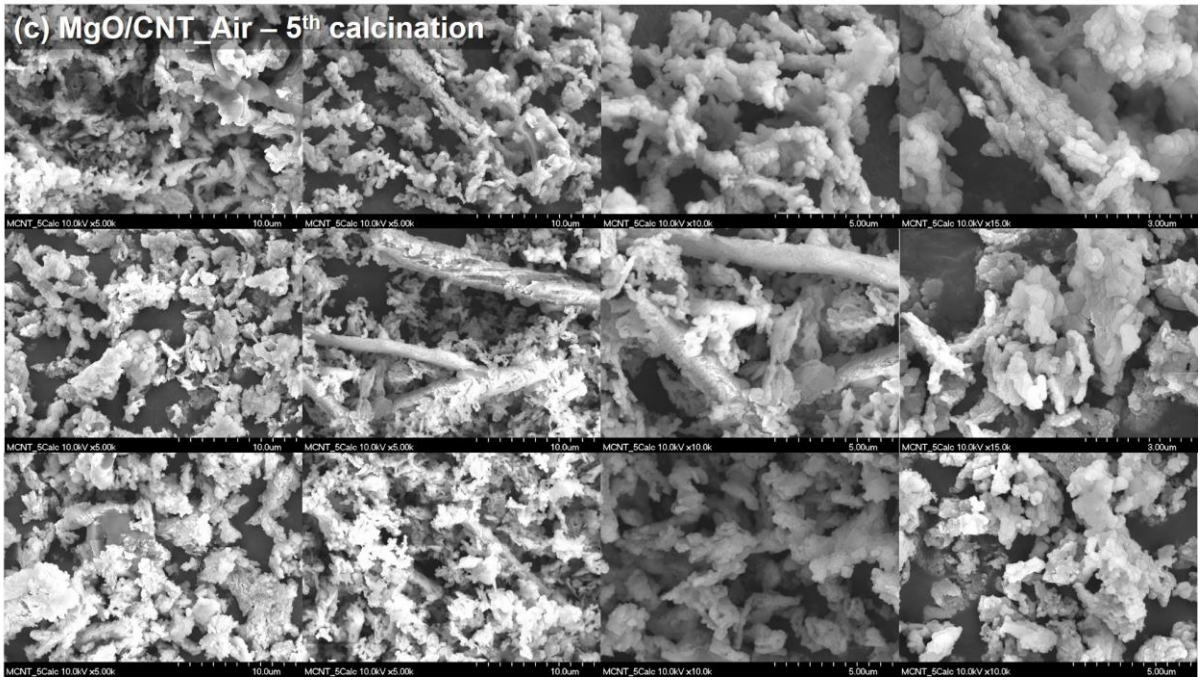



**Fig. S6.** SEM images of MgO-based sorbents after 30 cycle: (a) MgO/CNT_$N_2$, (b) MgO/CNT_Air, (c) MgO, and (d) MgO_HT.


(a) MgO/CNT_Air - 1st carbonation ($MgCO_3$)
MCNT_1Carb 10.0kV x2.00k 20.0um
MCNT_1Carb 10.0kV x5.00k 10.0um
MCNT_1Carb 10.0kV x10.0k 5.00um
MCNT_1Carb 10.0kV x15.0k 3.00um
MCNT_1Carb 10.0kV x8.00k 10.0um
MCNT_1Carb 10.0kV x4.00k 10.0um
MCNT_1Carb 10.0kV x8.00k 5.00um
MCNT_1Carb 10.0kV x10.0k 5.00um
MCNT_1Carb 10.0kV x4.00k 10.0um
MCNT_1Carb 10.0kV x5.00k 10.0um
MCNT_1Carb 10.0kV x15.0k 3.00um
MCNT_1Carb 10.0kV x15.0k 3.00um


(b) MgO/CNT_Air - 1st calcination
MCNT_1Calc 10.0kV x2.50k 20.0um
MCNT_1Calc 10.0kV x5.00k 10.0um
MCNT_1Calc 10.0kV x10.0k 5.00um
MCNT_1Calc 10.0kV x15.0k 3.00um
MCNT_1Calc 10.0kV x4.00k 10.0um
MCNT_1Calc 10.0kV x5.00k 10.0um
MCNT_1Calc 10.0kV x10.0k 5.00um
MCNT_1Calc 10.0kV x40.0k 1.00um
MCNT_1Calc 10.0kV x5.01k 10.0um
MCNT_1Calc 10.0kV x5.00k 10.0um
MCNT_1Calc 10.0kV x10.0k 5.00um
MCNT_1Calc 10.0kV x15.0k 3.00um


(c) MgO/CNT_Air – 5th calcination
MCNT_5Calc 10.0kV x5.00k 10.0um
MCNT_5Calc 10.0kV x5.00k 10.0um
MCNT_5Calc 10.0kV x10.0k 5.00um
MCNT_5Calc 10.0kV x15.0k 3.00um
MCNT_5Calc 10.0kV x5.00k 10.0um
MCNT_5Calc 10.0kV x5.00k 10.0um
MCNT_5Calc 10.0kV x10.0k 5.00um
MCNT_5Calc 10.0kV x15.0k 3.00um
MCNT_5Calc 10.0kV x5.00k 10.0um
MCNT_5Calc 10.0kV x5.00k 10.0um
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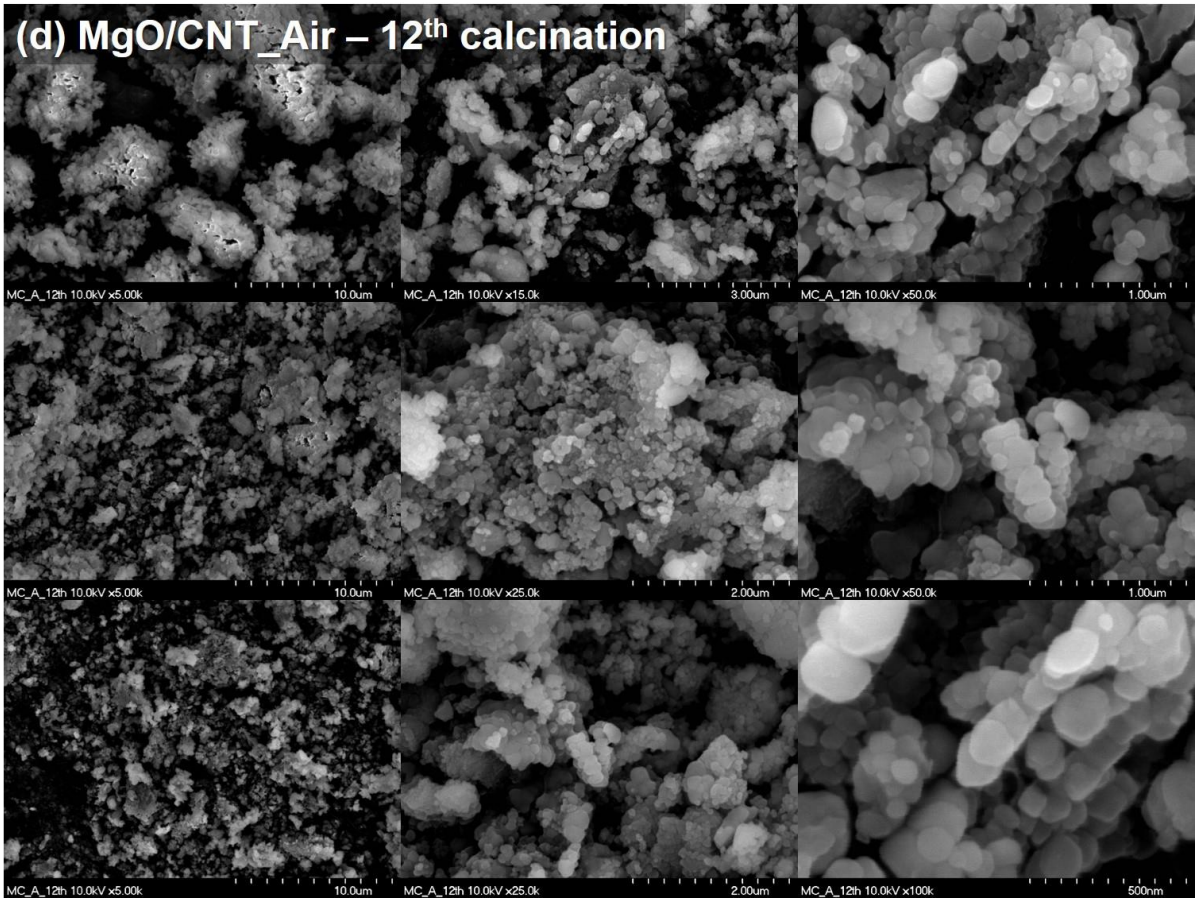
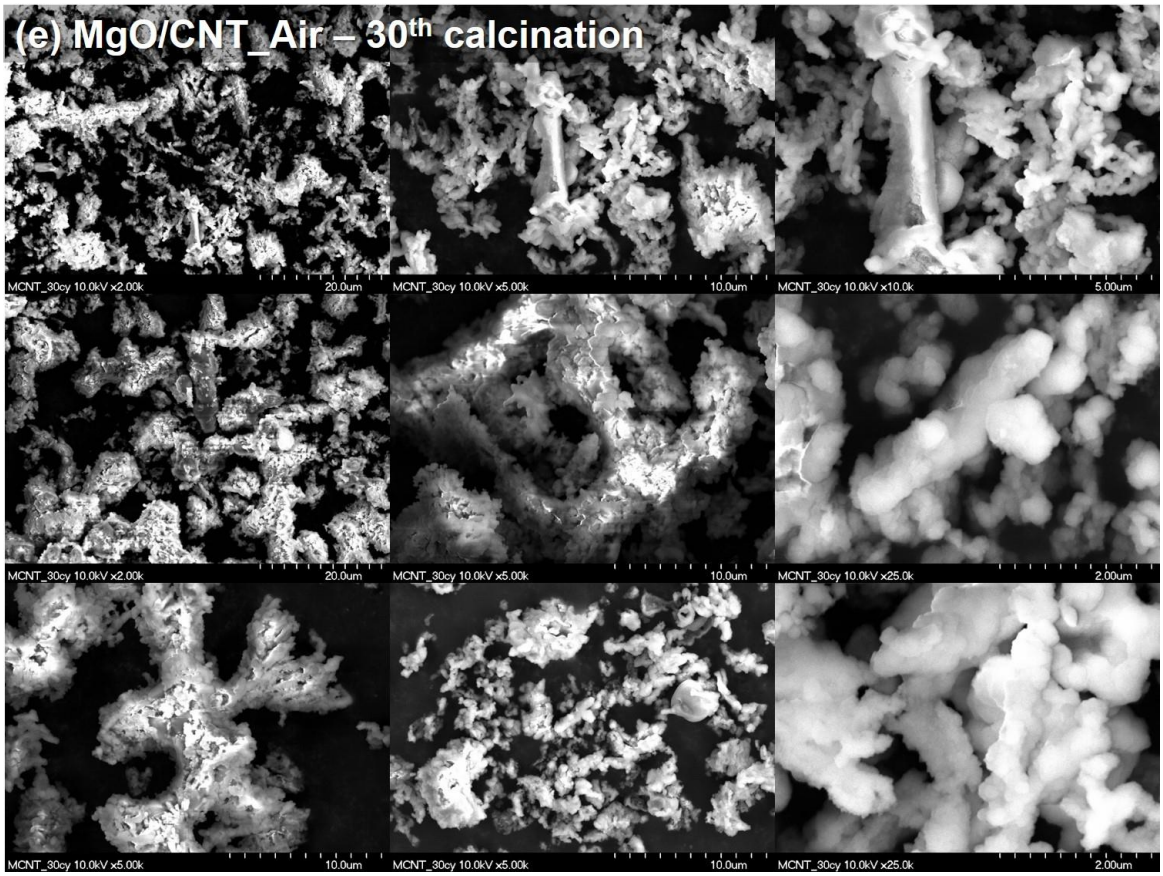

(d) MgO/CNT_Air – 12th calcination
MC_A_12th 10.0kV x5.00k 10.0um
MC_A_12th 10.0kV x15.0k 3.00um
MC_A_12th 10.0kV x50.0k 1.00um
MC_A_12th 10.0kV x5.00k 10.0um
MC_A_12th 10.0kV x25.0k 2.00um
MC_A_12th 10.0kV x50.0k 1.00um
MC_A_12th 10.0kV x5.00k 10.0um
MC_A_12th 10.0kV x25.0k 2.00um
MC_A_12th 10.0kV x100k 500nm


(e) MgO/CNT_Air – 30th calcination
MCNT_30cy 10.0kV x2.00k 20.0um
MCNT_30cy 10.0kV x5.00k 10.0um
MCNT_30cy 10.0kV x10.0k 5.00um
MCNT_30cy 10.0kV x2.00k 20.0um
MCNT_30cy 10.0kV x5.00k 10.0um
MCNT_30cy 10.0kV x25.0k 2.00um
MCNT_30cy 10.0kV x5.00k 10.0um
MCNT_30cy 10.0kV x5.00k 10.0um
MCNT_30cy 10.0kV x25.0k 2.00um

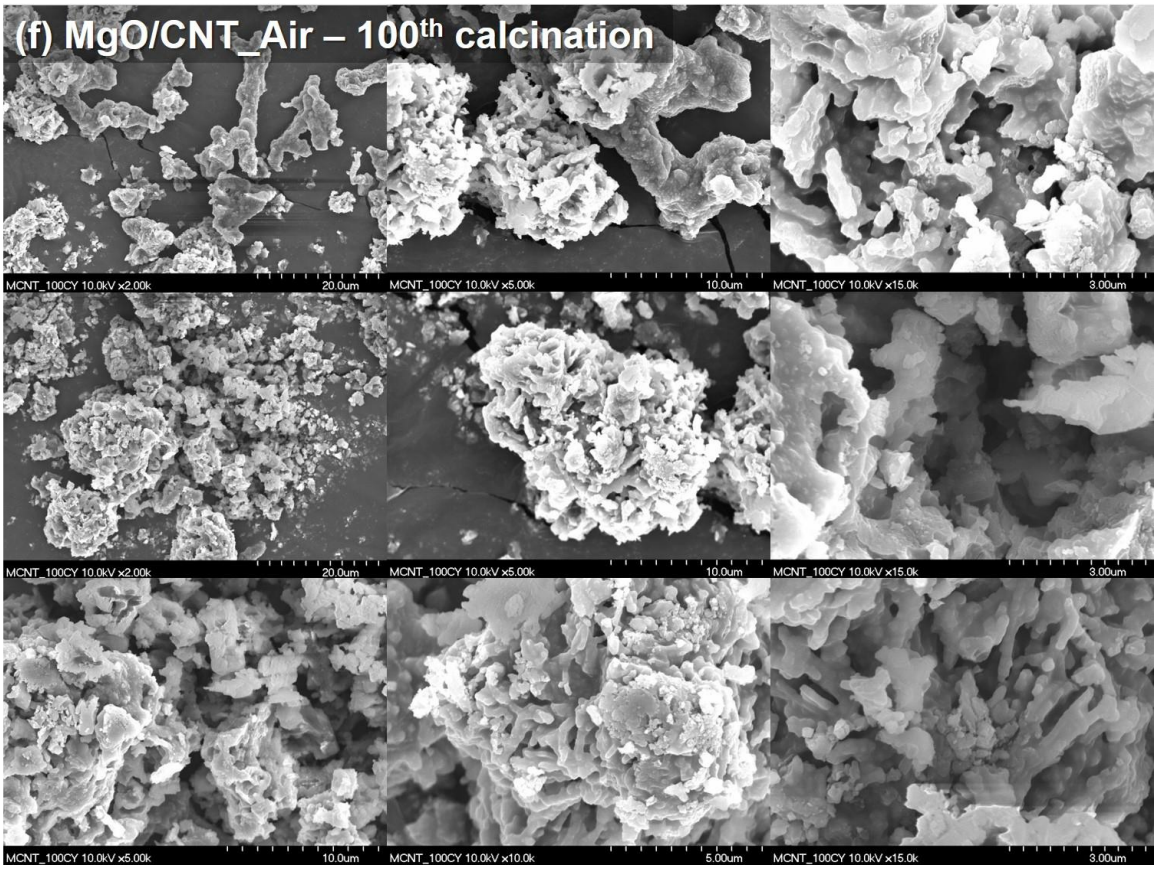
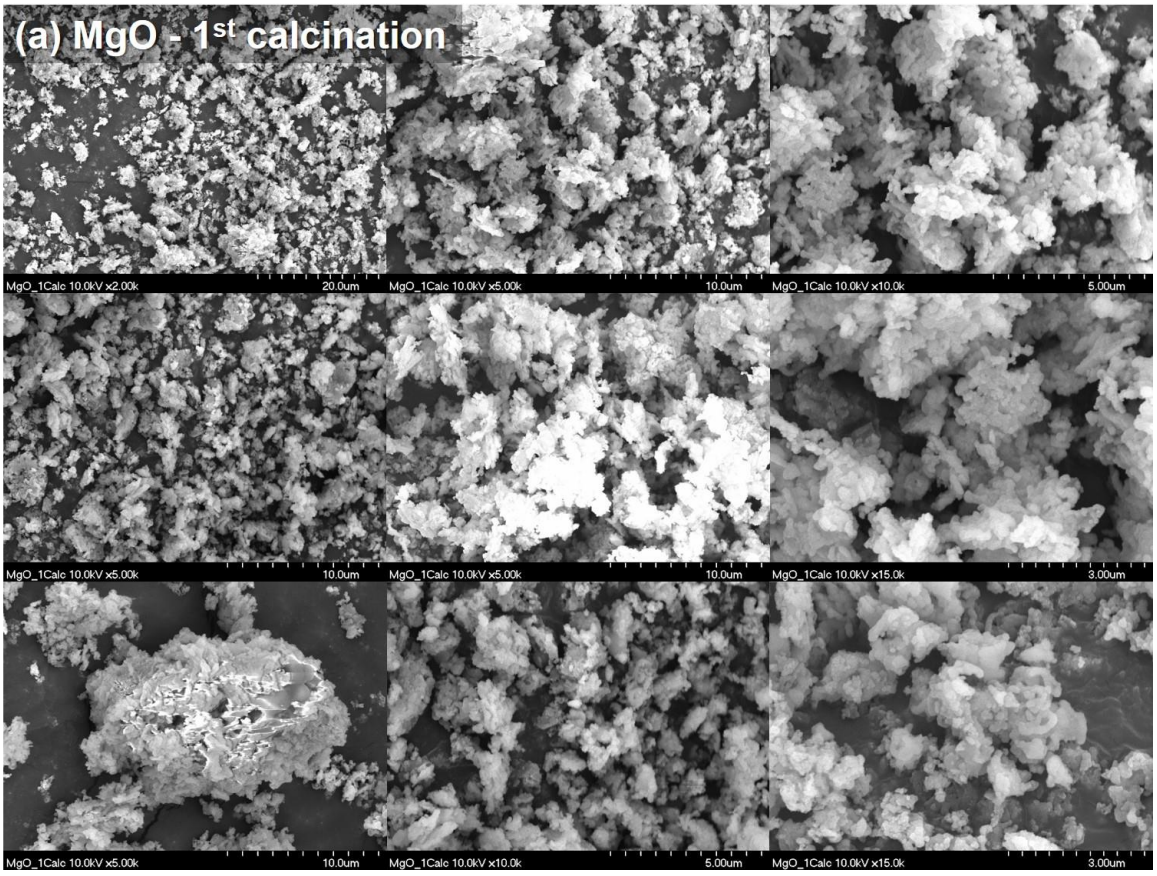

(f) MgO/CNT_Air – 100th calcination
MCNT_100CY 10.0kV x2.00k 20.0um
MCNT_100CY 10.0kV x5.00k 10.0um
MCNT_100CY 10.0kV x15.0k 3.00um
MCNT_100CY 10.0kV x2.00k 20.0um
MCNT_100CY 10.0kV x5.00k 10.0um
MCNT_100CY 10.0kV x15.0k 3.00um
MCNT_100CY 10.0kV x5.00k 10.0um
MCNT_100CY 10.0kV x10.0k 5.00um
MCNT_100CY 10.0kV x15.0k 3.00um

**Fig. S7**. SEM images of MgO/CNT_Air: (a) 1st carbonation ($MgCO_3$), (b) 1st calcination, (c) 5th calcination, (d) 12th calcination, (e) 30th calcination, and (f) 100th calcination.


(a) MgO - 1st calcination
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MgO_1Calc 10.0kV x5.00k 10.0um
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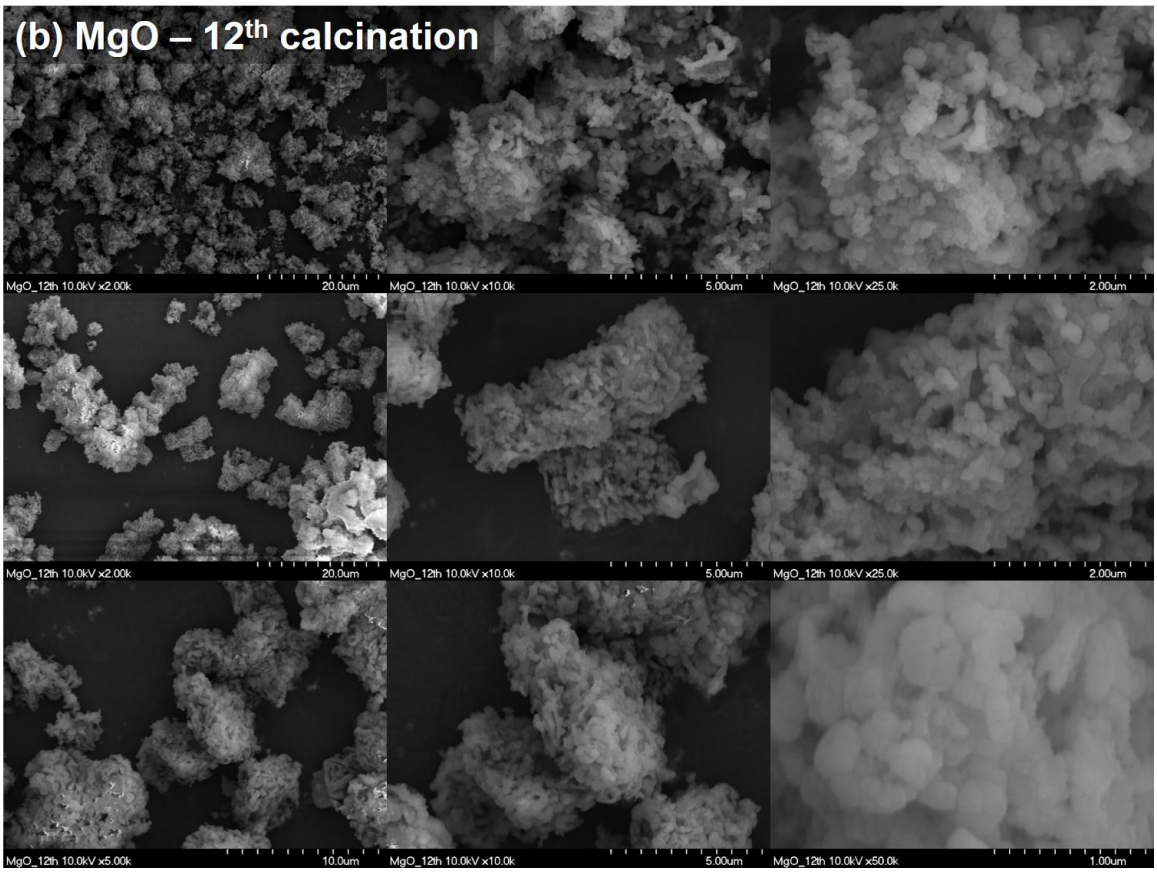
MgO_1Calc 10.0kV x5.00k 10.0um
MgO_1Calc 10.0kV x5.00k 10.0um
MgO_1Calc 10.0kV x15.0k 3.00um
MgO_1Calc 10.0kV x5.00k 10.0um
MgO_1Calc 10.0kV x10.0k 5.00um
MgO_1Calc 10.0kV x15.0k 3.00um


(b) MgO – 12th calcination
MgO_12th 10.0kV x2.00k 20.0um
MgO_12th 10.0kV x10.0k 5.00um
MgO_12th 10.0kV x25.0k 2.00um
MgO_12th 10.0kV x2.00k 20.0um
MgO_12th 10.0kV x10.0k 5.00um
MgO_12th 10.0kV x25.0k 2.00um
MgO_12th 10.0kV x5.00k 10.0um
MgO_12th 10.0kV x10.0k 5.00um
MgO_12th 10.0kV x50.0k 1.00um

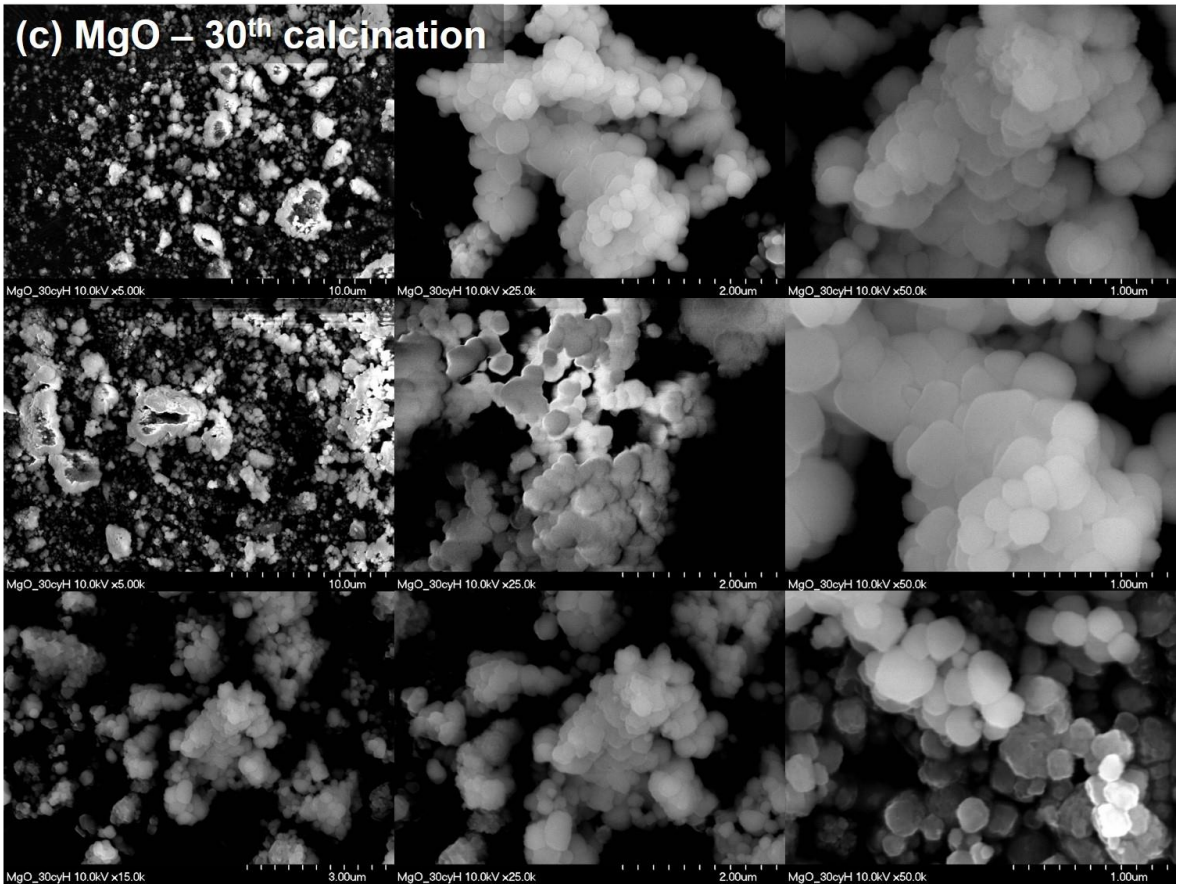



**Fig. S8**. SEM images of MgO: (a) 1st calcination, (b) 12th calcination, and (c) 30th calcination.

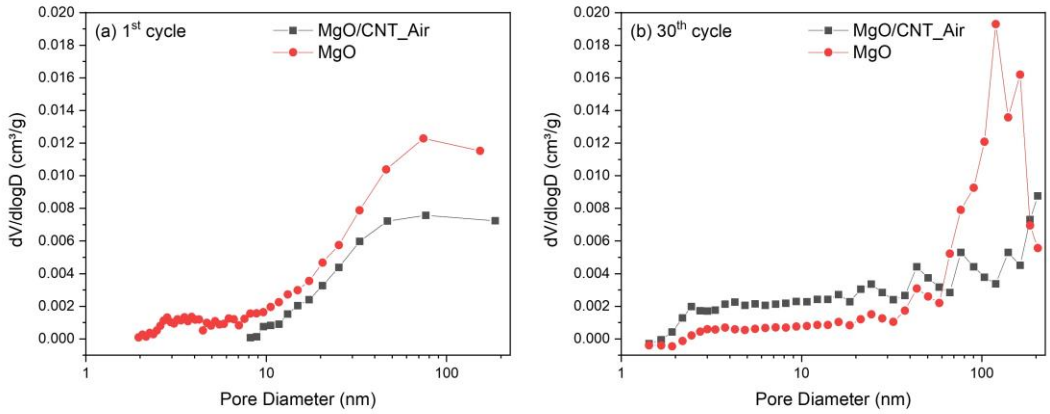



**Fig. S9**. BJH adsorption pore distribution of MgO/CNT_Air and MgO (a) after one carbonation-calcination reaction, and (b) after 30$^{th}$ carbonation-calcination reaction.

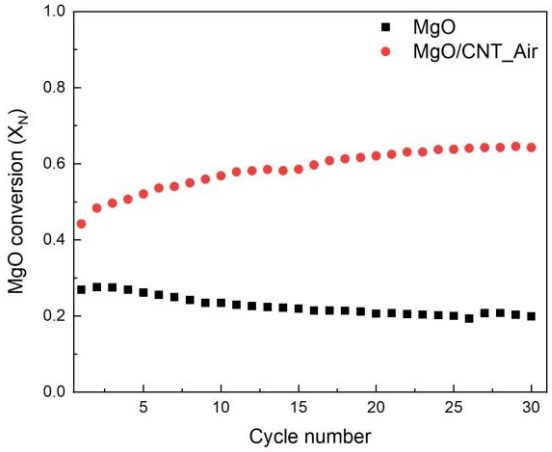



**Fig. S10**. $CO_2$ capture performance of MgO and MgO/CNT_Air for 30 cycles under reaction condition for preparing BET samples by TG-DSC.