# Supporting Information

Table S1. Calculated lattice parameters , a and c of $Co(OH)_2$ of Pre 1, Pre 2 and Pre 3, in comparing with the standard $Co(OH)_2$ and $Ca(OH)_2$ lattice parameters.

| Parameter | Pre 1 | Pre 2 | Pre 3 | Standard $Co(OH)_2$ | Standard $Ca(OH)_2$ |
|---|---|---|---|---|---|
| a (nm) | 0.3181 | 0.3236 | 0.3265 | 0.3183 | 0.3590 |
| c (nm) | 0.4651 | 0.4776 | 0.4817 | 0.4652 | 0.4916 |

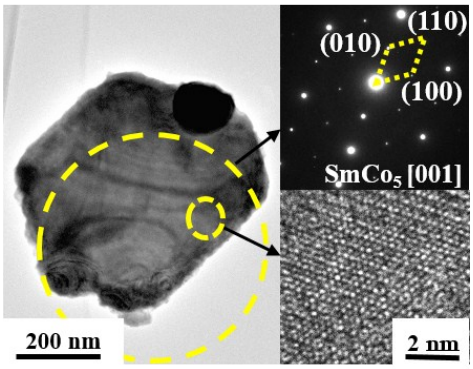


Fig. S1 A TEM image of one $SmCo_5$ particle in S3, with insets of the SEAD pattern and HRTEM image.

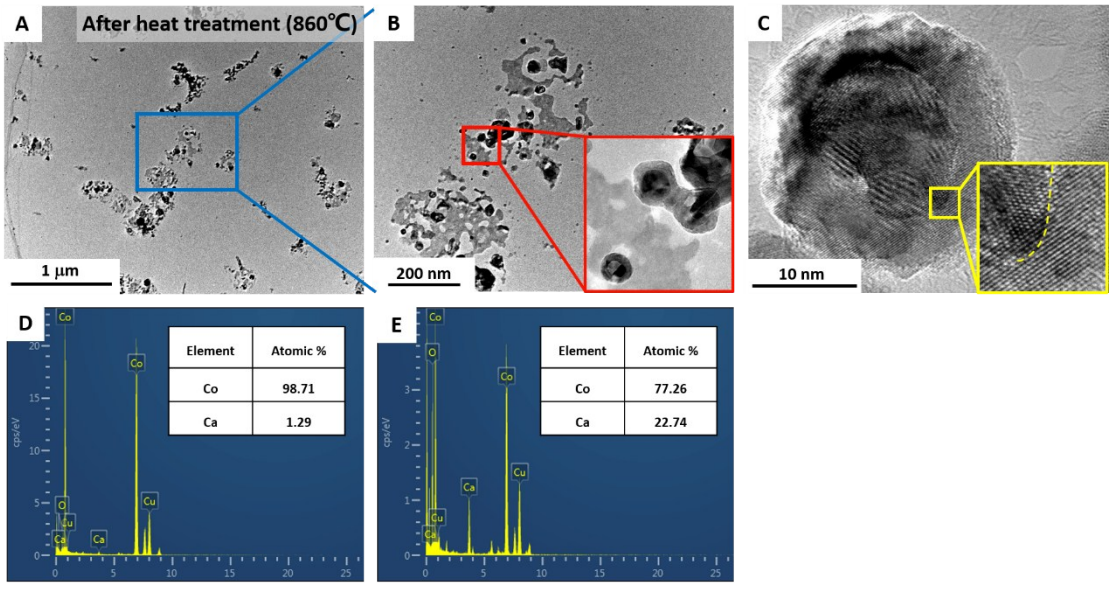


Fig. S2. Characterization of Pre 3 after heat treatment with a condition of 860 ℃, 10 min and in argon. A) TEM image of Pre 3 after heat treatment; B) Zoom-in image of the area circled by blue line in (A) and inset shows a zoom-in image of the area circled by red line; C) HRTEM image of a CoO/CaO core/shell structure and the inset shows HRTEM image of a local area; D, E) shows the EDS spectrum and corresponding elements ratio of the core and shell separately.

As shown in Fig. S1A, the precursor nanoflakes and flocs decomposed into small nanoparticles after heat treatment with a condition of 860 °C, 10 min and in argon. As the decomposition was constricted by the carbon film, the nanoflake shape was conserved, as shown in the blue box area. Zoom-in image in Fig. S1B shows that some core/shell structure was formed and some area with low contrast still kept nanoflake structure, which may be due to the inadequate diffusion in the short time as well as the constriction of the carbon film. According to the contrast difference as shown in the HRTEM image of a core/shell nanoparticle in Fig. S1C and the EDS results of core (Fig. S1D) and shell (Fig. S1F), the core is almost Co and the shell contains 22.7 a.t.% Ca. Therefore, diffusion process occurred together with the coherent $Co(OH)_2$ and $Ca(OH)_2$ dehydration process.