

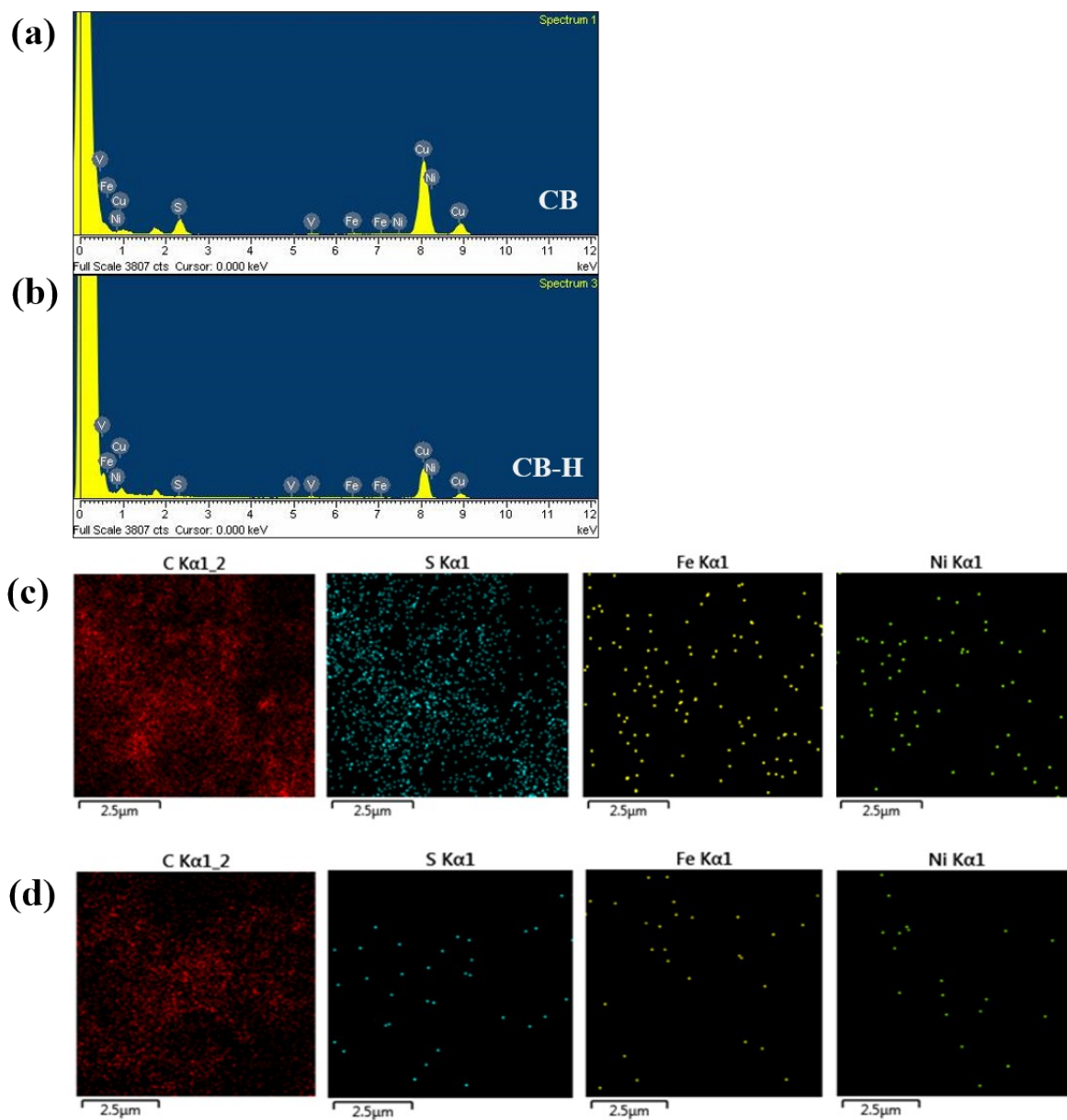
## Electronic Supplementary Information

### Preparation of graphene hollow sphere from vacuum residue of ultra-heavy oil as effective oxygen electrode in Li-O<sub>2</sub> battery

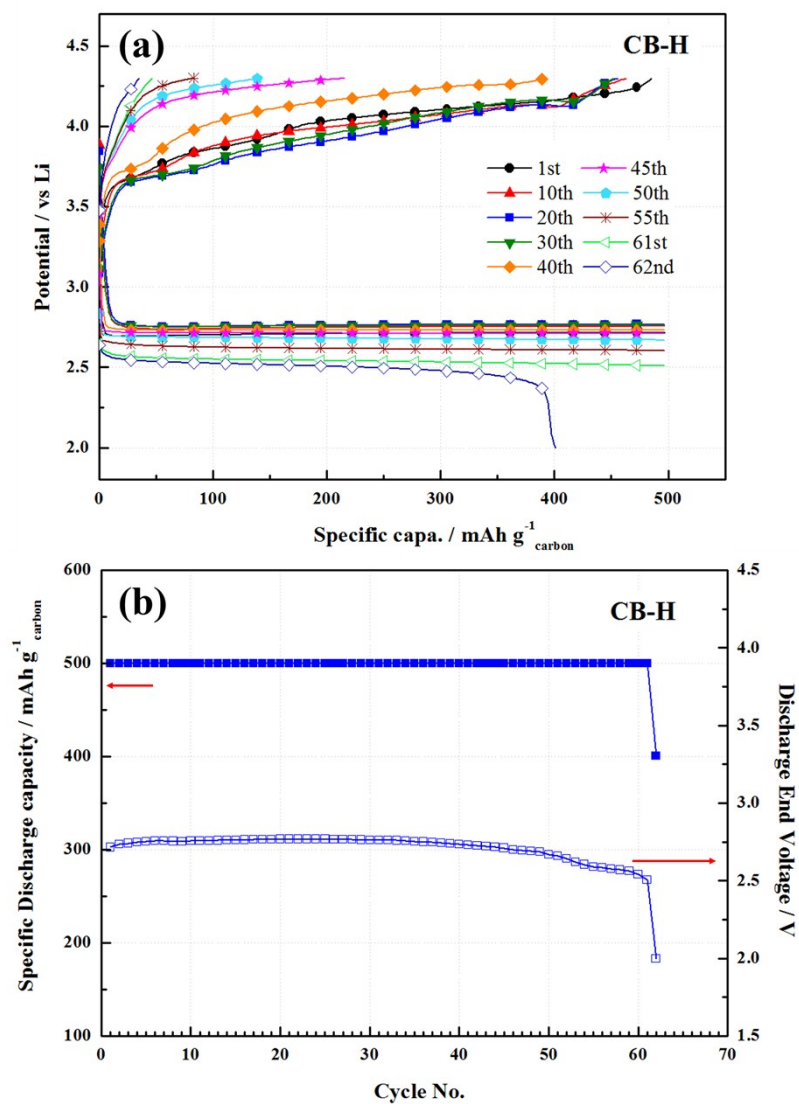
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**Table S1.** Components of Vacuum Residue

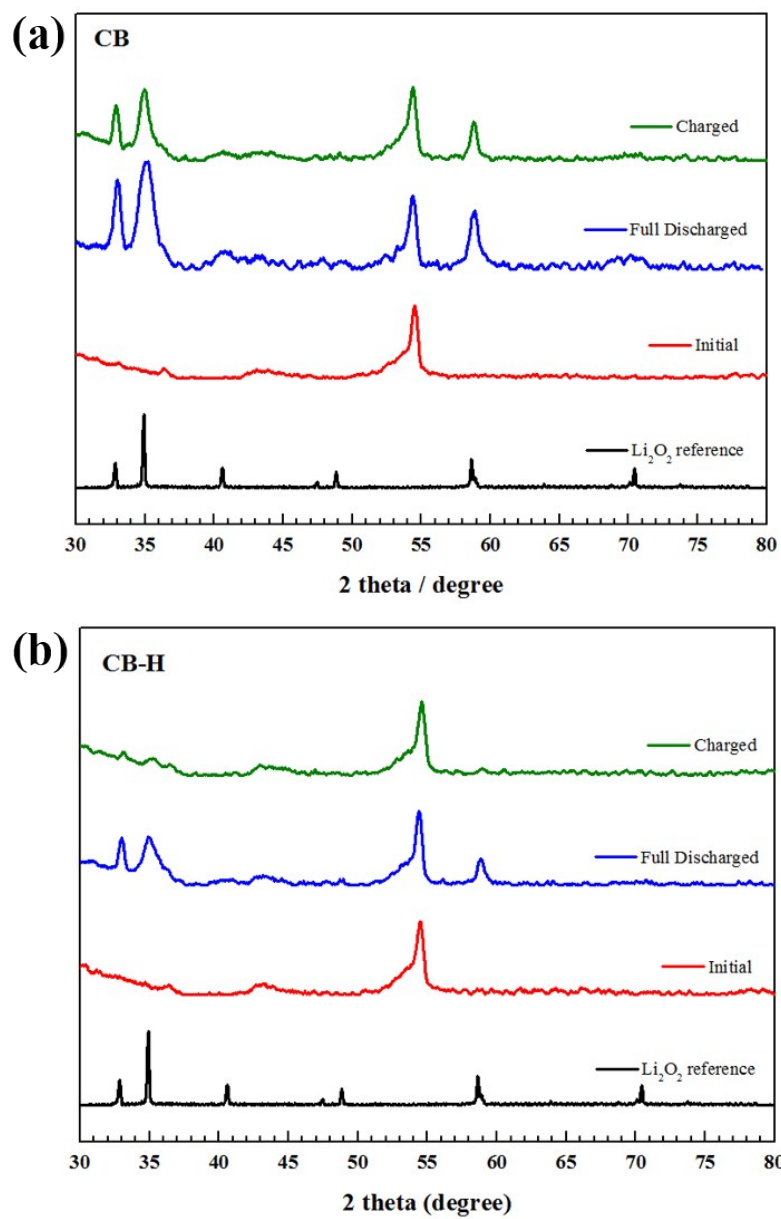
<b>Components of Vacuum Residue</b>	
<b>Conradson carbon residue, wt. %</b>	22.2
<b>S, wt. %</b>	5.3
<b>N, wt. %</b>	0.3
<b>Ni, wppm</b>	55.2
<b>V, wppm</b>	154.3
<b>Fe, wppm</b>	102.9



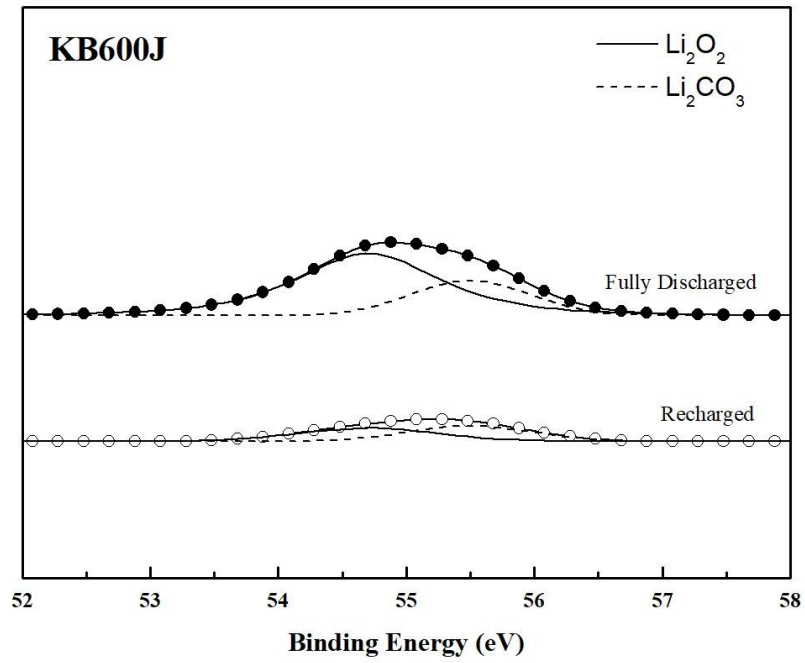
**Fig. S1** EDS spectra of (a) CB, (b) CB-H and mapping images of (c) CB and (d) CB-H.



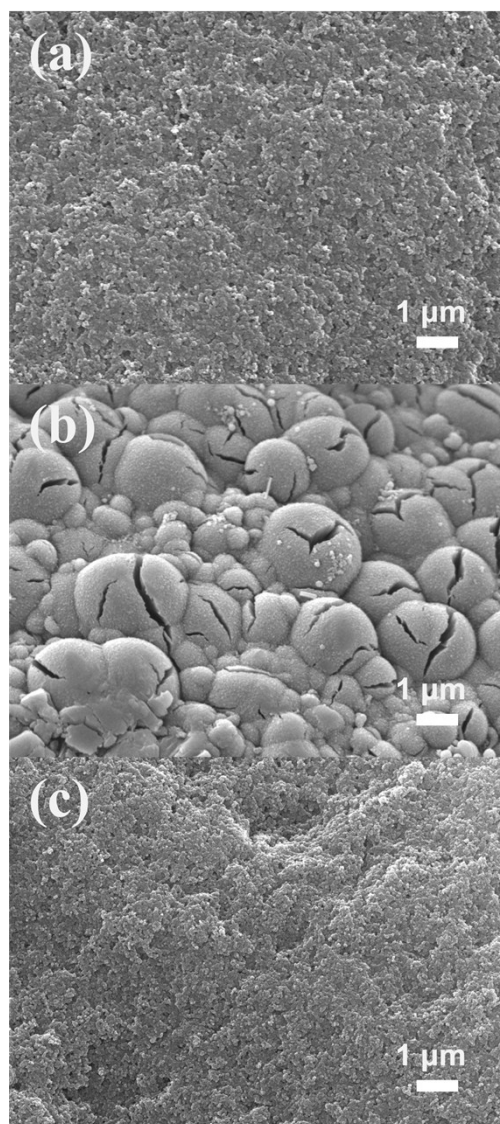
**Fig. S2** (a) Cycle stability result for CB-H at a constant current density of  $1,000 \text{ mA g}^{-1}_{\text{carbon}}$  with curtaining capacity of  $500 \text{ mAh g}^{-1}_{\text{carbon}}$  and (b) the change in discharge capacities and the discharge end voltage.



**Fig. S3** XRD spectra of (a) CB and (b) CB-H at initial, discharged, and charged states.



**Fig. S4** Li 1s spectra of KB600J after a full discharge and recharge process



**Fig. S5** SEM images of KB600J at (a) initial, (b) fully discharged, and (c) recharged states.