

**Table S1.** Textural properties of Samples.

Sample	$S_{\text{BET}}$ / $\text{m}^2\cdot\text{g}^{-1}$	$V_{\text{total}}$ / $\text{cm}^3\cdot\text{g}^{-1}$	$V_{\text{micro}}$ / $\text{cm}^3\cdot\text{g}^{-1}$	Average pore sizes/nm
SH	0.43	0.01	0.00	21.77
SH-850	133	0.14	0.06	4.30
ASH-850	1486	0.93	0.71	2.51
ASH-4-850	1411	1.16	0.63	3.30

Remark: ASH-4-850 sample was prepared with 4 times dosage of KOH as ASH-850 under the same condition but without Ni (NO<sub>3</sub>)<sub>2</sub> (the relevant data was published in our paper: Ai, Ning, Sa Lou, Fengyan Lou, Chengda Xu, Qining Wang, and Ganning Zeng. Facile synthesis of macroalgae-derived graphene adsorbents for efficient CO<sub>2</sub> capture. Process Safety and Environmental Protection 2021, 148: 1048-1059. )

**Table S2.** CO<sub>2</sub> equilibrium adsorption capacities of carbon materials at 30 °C.

Samples	CO <sub>2</sub> adsorption capacity( $q_{\text{max}}$ ) /(mmol·g <sup>-1</sup> )			
	SH-850	ASH-750	ASH-850	ASH-4-850
30 °C	1.03	2.33	2.51	2.78

Remark: Compared with SH-850, ASH-750 and ASH-850, the CO<sub>2</sub> uptake capacities of ASH-750 and ASH-850 were both superior to SH-850. It illustrated that Ni (NO<sub>3</sub>)<sub>2</sub> /KOH as a co-catalyst can prepare adsorbent with good performance; Compared with ASH-850 and ASH-4-850, it can be seen that without Ni (NO<sub>3</sub>)<sub>2</sub>, four times dosage of KOH was needed to achieve the similar BET and results. Thus there is a synergistic effect of Ni (NO<sub>3</sub>)<sub>2</sub> /KOH for preparing high-performance activated carbon.