

Supporting information

Carbon nanotube-alumina strips as robust, rapid, reversible adsorbents of organics

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SI-1 Characterization of sample

Transmission electron microscope (TEM, JEOL2010, operated at 200 kV) and scanning electron microscope (SEM, JSF7600, operated at 10kV) were used to characterize the structure or morphology of CNTs and CASs. Nitrogen isothermal adsorption (77K) was used to obtain the surface area and pore structure of CNTs and CASs. The mercury compression method (AutoPore IV, 9500) is used to determine the macropores of GNHs. Thermo-gravimetric analysis (TGA, TA2050, air, the elevated heating rate is 5K/min) were used to determine the purity of CNTs and to obtain DTA data. FT-IR (Nicolet) was used to characterize the functional groups of different samples.

For the adsorption test, 40 g of CASs were firstly put into the round bottom flask. Then pure para-xylene liquid with excess amount was added into the same flask. The adsorption process was kept for about one hour at ambient condition to achieve a saturation adsorption equilibrium of para-xylene in CASs. Then CASs was filtered to separate and to remove the excess para-xylene. The mass of CASs after adsorption was measured to calculate their adsorption capacity of para-xylene. For the desorption operation, the flask containing adsorbed CASs was connected to a vacuum pump. Para-xylene begin to escape out of the pores of CASs at 85°C with vacuum degree of -0.08MPa. The operation can last about 20 minutes till the mass of CASs with para-xylene didn't decrease any more. For CNT powder and activated carbon, vacuum desorption become low efficiency when adsorption capacity is about 40%. Then high temperature gas purging is used for the further desorption.

SI-2 TEM image of carbon nanotubes

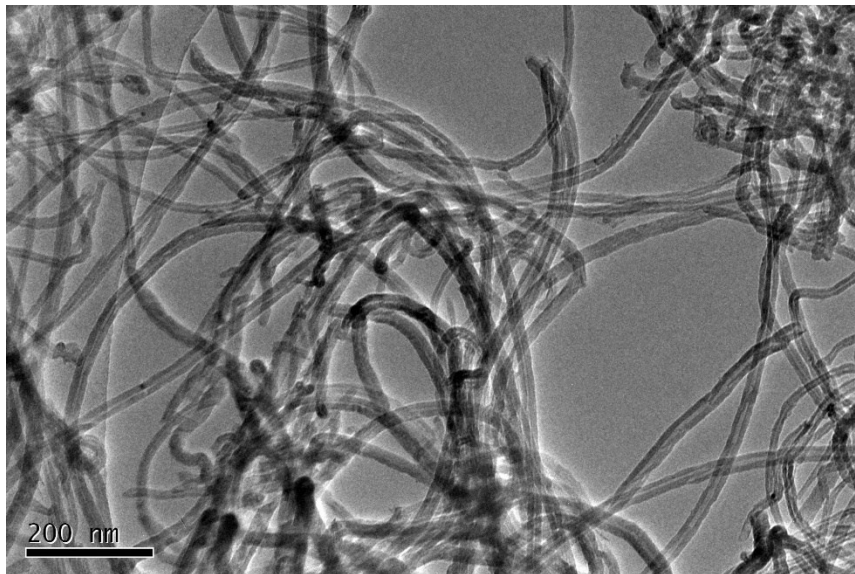


Fig.S1 TEM image of carbon nanotubes used in the present work

SI-3 Pores by mercury compression

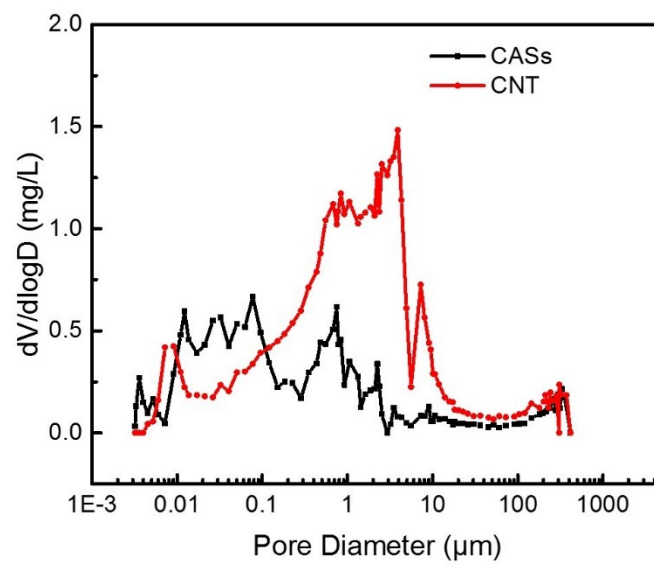


Fig S2 pore diameter distribution of CASs and CNTs

SI-4 FT-IR pattern of CASs

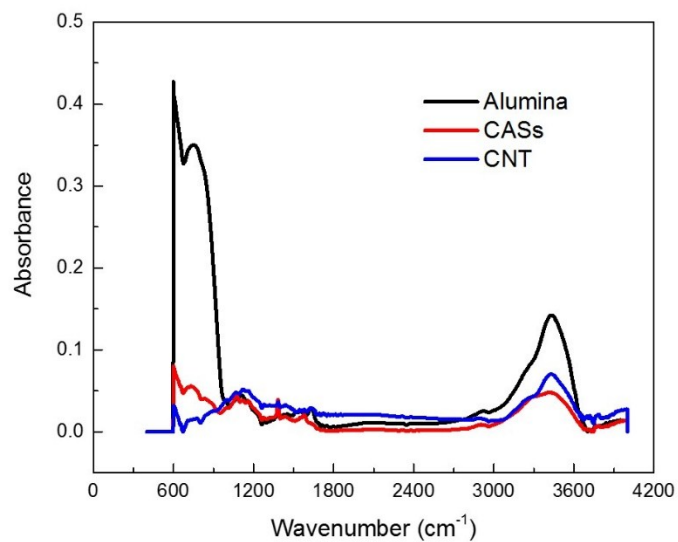


Fig S3 FT-IR pattern of CASs, CNT and alumina

SI-5 Morphology of CNT powder after adsorption and after desorption

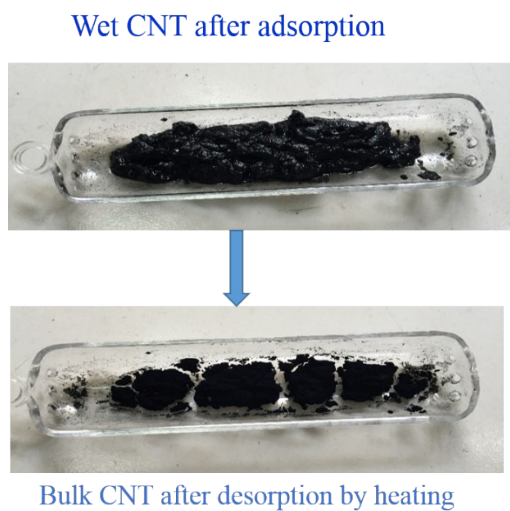


Fig.S4 Morphology of CNT powder after adsorption and after desorption

SI-6 Measurement of the bed pressure drop in an Adsorption tower

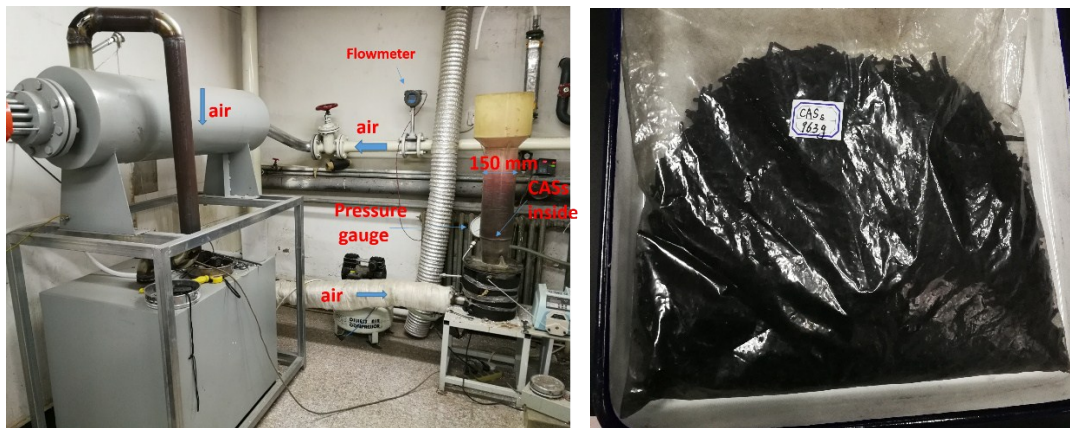


Fig. S5 Apparatus to measure the bed pressure drop and bag of holding CASs of 963 g. The diameter of the tower is 150 mm. The amount of CASs is 963 g and the associated bed height is 24 cm. CASs was randomly packed and not compressed by any internals.

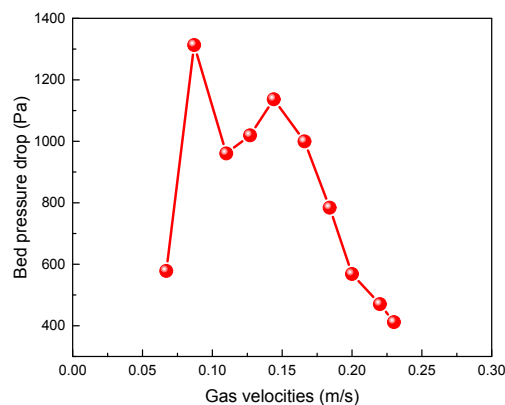


Figure S6 Bed pressure drop of CASs under different gas velocities.

As changing the flow rate of air, we obtained different gas velocities and the associated bed pressure drop. Firstly, the pressure drop was measured without packing CASs. The blank pressure drop (ΔP_0) is caused by the value, pipe and the gas distributor. One pressure gauge is sufficient to obtain the data, since the exit is open to air.

Total pressure drop (ΔP_1) can be obtained after packing CASs of 963g. Thus, the pressure drop (ΔP) caused by CASs by $\Delta P = \Delta P_1 - \Delta P_0$.

ΔP increased linearly in the range of 0.6-0.9 m/s, in which range of gas velocity the bed remained stable. Further increase of gas velocity resulted in the movement of some CASs. But the bed pressure remained nearly constant in the range of 0.12-0.18 m/s.

Too large gas velocity resulted in the much unstable operation, where nearly all CASs moved, resulting in a shortcut of gas and decreased pressure drop. The value is reasonable since packed bed always operated in a gas velocity lower than 0.15 m/s and fluidized bed always operated at gas velocity higher than 0.15 m/s.

The pressure drop in 0.06-0.09 m/s is quite low for the adsorption tower.