Supplementary Information

Carbon Foam with Microporous Cell wall and Strut for CO₂ Capture

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Experimental

Preparation of Carbon foams: Sucrose (250 g) and AN (1 to 5 wt.% of sucrose) were intimately mixed using an agate mortar and pestle. The mixtures were heated in a 1 liter borosilicate glass reaction kettle using a heating mantle for 15 minutes to form dark brown homogeneous melts. The contents were mechanically stirred during the melting. The melts were transferred into borosilicate glass trays of 2.5 liters capacity and kept in an air oven at 150 °C for 24 hours for foaming and setting. The molten sucrose without AN took nearly 72 hours for foaming and setting. The solid organic foams obtained were dehydrated at 250°C in air oven and then carbonized at various temperatures in the range of 400 to 900 °C in high pure argon atmosphere for 2 hours to form the carbon foams. The heating rate used was 2 °C/min.

Characterizations

The carbon foam microstructures were obtained using scanning electron microscopy (SEM) (FEI Quanta FEG200). High resolution transmission microscopy (HR-TEM) images were obtained using JEOL (JEM – 200) operating at 200 kV. The porous textural properties of the carbon foams were analyzed using the volumetric N_2 adsorption-desorption at -196 °C and CO₂ adsorption at 0 °C using a surface area analyzer (Micromeritics Tristar II, USA). The samples were degassed at 300 °C for 16 hours prior to the analysis. The BET (Brunauer-Emmett-Teller) method was used for the calculation of the surface area. Necessary precautions were taken to get the reliable BET surface area for the microporous materials as explained elsewhere. ¹The total pore volume was estimated from the amount of N_2 adsorbed at the relative pressure of 0.99. The micropore volume was obtained by using t-plot method in N_2 adsorption at -196 °C. The pore size distribution (PSD) was calculated using density functional theory (DFT) using N_2 adsorption isotherm by assuming slit pore model. The information about the ultramicropores was obtained

from CO₂ adsorption isotherm at 0 °C as explained elsewhere.² Elemental analysis was carried out using an elemental analyzer (PerkinElmer 2400 series II, USA). The functional group characterization of the powdered samples was carried out using Fourier transforms infra-red spectrometer (FTIR, Spectrum-150, Perkin Elmer, USA).

 CO_2 adsorption studies: The CO₂ adsorption of the carbon foam samples was evaluated at 0 and 25 °C by volumetric gas adsorption studies using a surface area analyzer (Micromeritics Tristar II, USA). Prior to the measurements, the samples were crushed using an agate and mortar and degassed overnight at 300 °C. The heat of adsorption was obtained by using a differential scanning calorimeter (DSC, TA Instruments Q20, USA).



Figure S1. XRD spectrum of the carbon foam showing turbostratic graphite structure



Figure S2. Stress-strain graph of the carbon foams



Figure S3. FTIR spectrum of the carbon foam sample carbonized at 400 $^{\circ}$ C



Figure S4. Schematic showing the formation of micropores by the alumina pillaring





Figure S5. (a) TEM photomicrograph, (b) selected area diffraction pattern and (c) XRD spectrum of the alumina obtained by burning off carbon from the carbon foams at 600 °C for 5 hours



Figure S6. CO_2 adsorption at 25 °C of carbon foams prepared at various carbonization temperatures

Calculation of CO₂:N₂ Selectivity

We calculated the initial slope of the gas uptake for both N_2 and CO_2 . The ratio of the slopes was used for calculating the selectivity at 25 $^{\circ}C.^3$





Figure S7. Initial slope calculation for CO_2 and N_2 isotherms collected at 25 °C. (a – c) 0, 2 and 4 wt.% AN

References

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