Electronic Supplementary Material (ESI) for Materials Advances.

Supporting Information

Porous carbons from sustainable and mild activation for targeted high-performance CO_2 capture and storage

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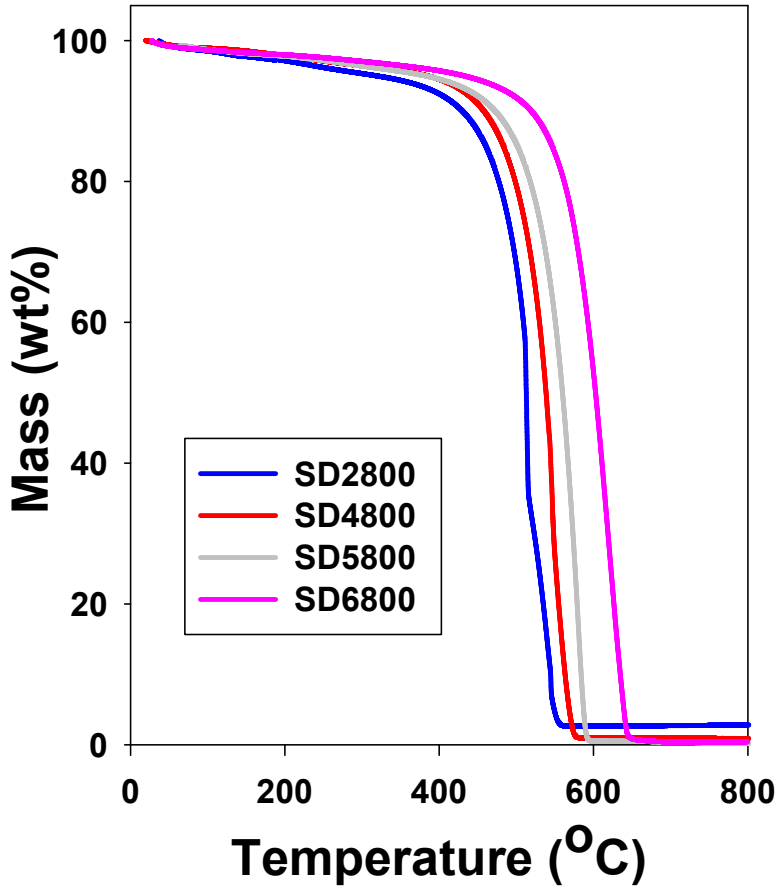
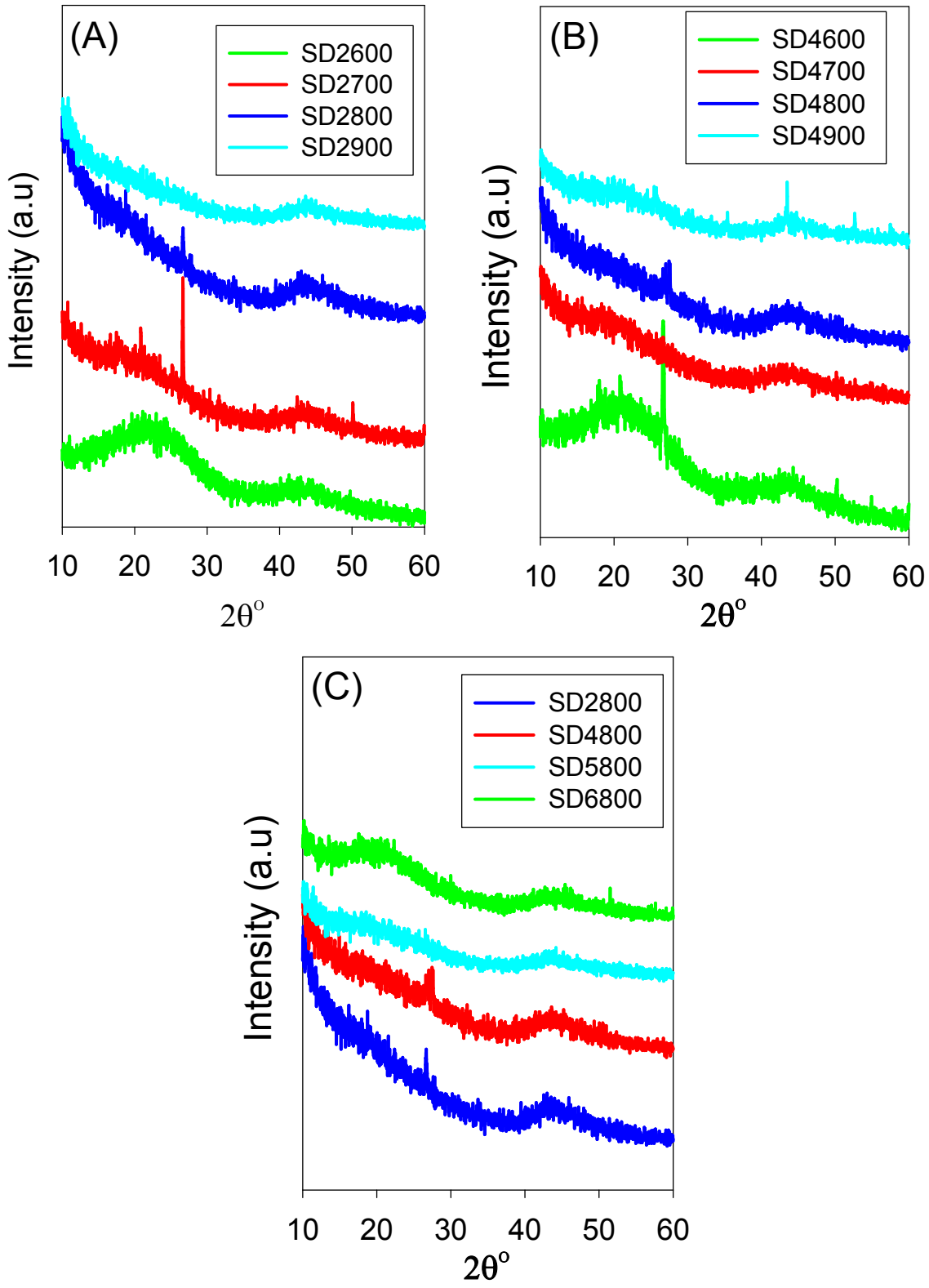
Table S1. Yield and elemental analysis of carbons prepared at PO/precursor ratio of 2 from sawdust hydrochar (SD), polypyrrole (Ppy), and pre-mixed precursors containing sawdust hydrochar and polypyrrole (Ppy-SD).

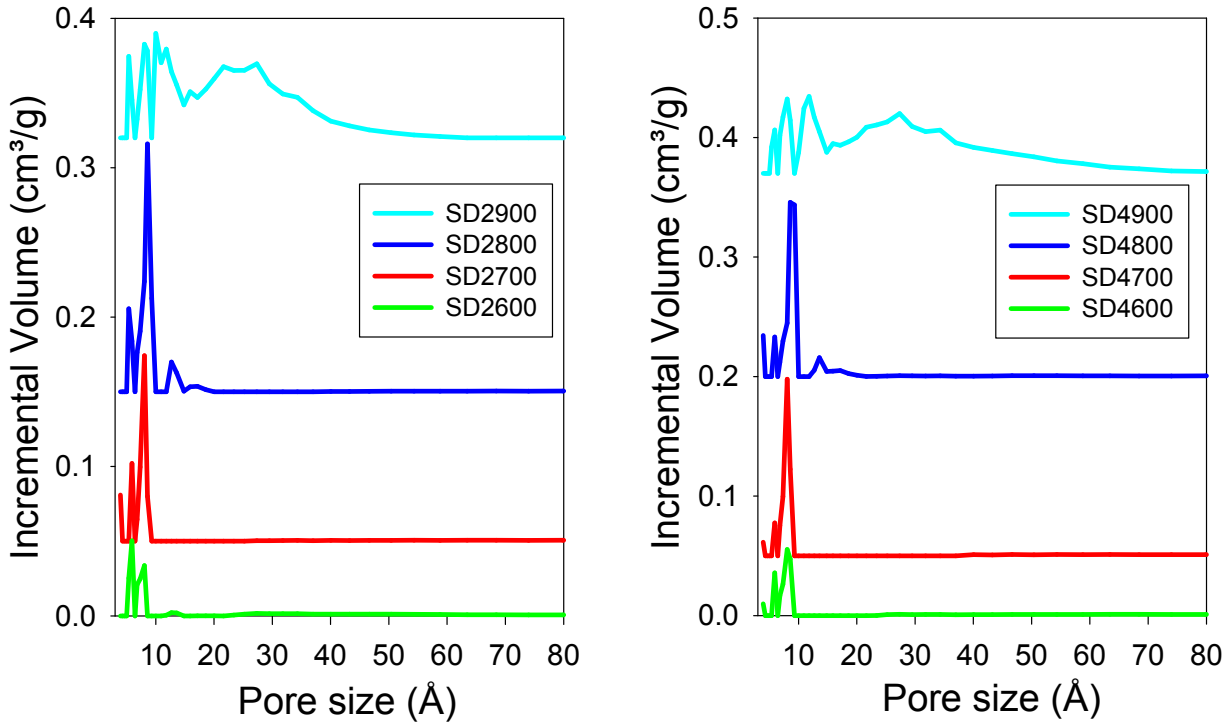
Sample	Yield (wt%)	Elemental composition (wt%)			
		C	H	N	O
SD2600	43	78.9	1.4	0.7	19.0
SD2700	41	81.1	0.2	0.2	18.5
SD2800	33	87.7	0	0.1	12.2
SD2900	21	90.7	0	0.2	9.1
Ppy-SD(1-2)2600	48	71.9	1.9	5.6	20.6
Ppy-SD(1-2)2700	27	74.0	1.8	2.9	21.3
Ppy-SD(1-2)2800	31	85.0	0.1	0.3	14.6
Ppy-SD(1-2)2900	17	91.4	0.0	0.4	8.2
Ppy-SD(1-1)2600	52	68.4	1.9	8.0	21.7
Ppy-SD(1-1)2700	39	80.2	0.3	2.0	17.5
Ppy-SD(1-1)2800	31	88.9	0.0	0.6	10.5
Ppy-SD(1-1)2900	18	91.4	0.0	0.7	7.9
Ppy-SD(2-1)2600	54	66.3	2.1	9.4	22.2
Ppy-SD(2-1)2700	39	73.7	0.3	2.3	23.7
Ppy-SD(2-1)2800	32	86.5	0.0	0.5	13.0
Ppy-SD(2-1)2900	19	90.1	0.0	0.5	9.4
Ppy2600	62	63.6	1.7	12.2	22.5
Ppy2700	43	77.6	0.8	4.0	17.6
Ppy2800	31	88.5	0.0	0.9	10.6
Ppy2900	24	91.9	0.0	1.2	6.9



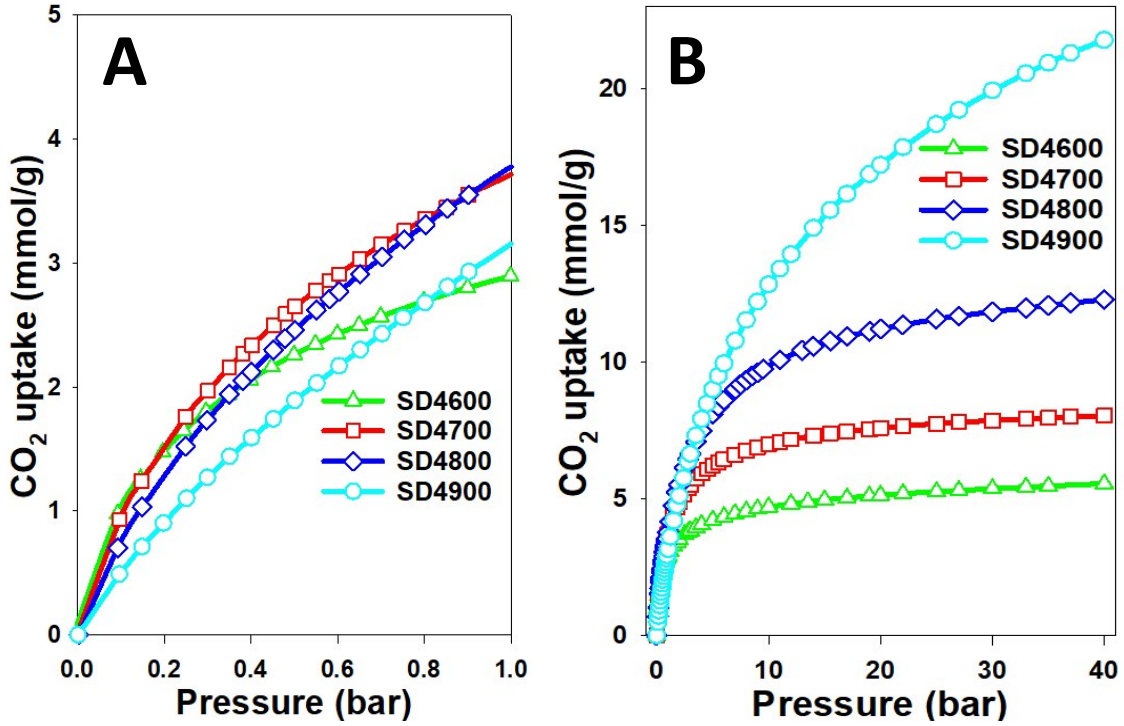
Supporting Figure S1. Thermogravimetric analysis of samples activated at of 800 °C and PO/SD ratio of 2, 4, 5 and 6.



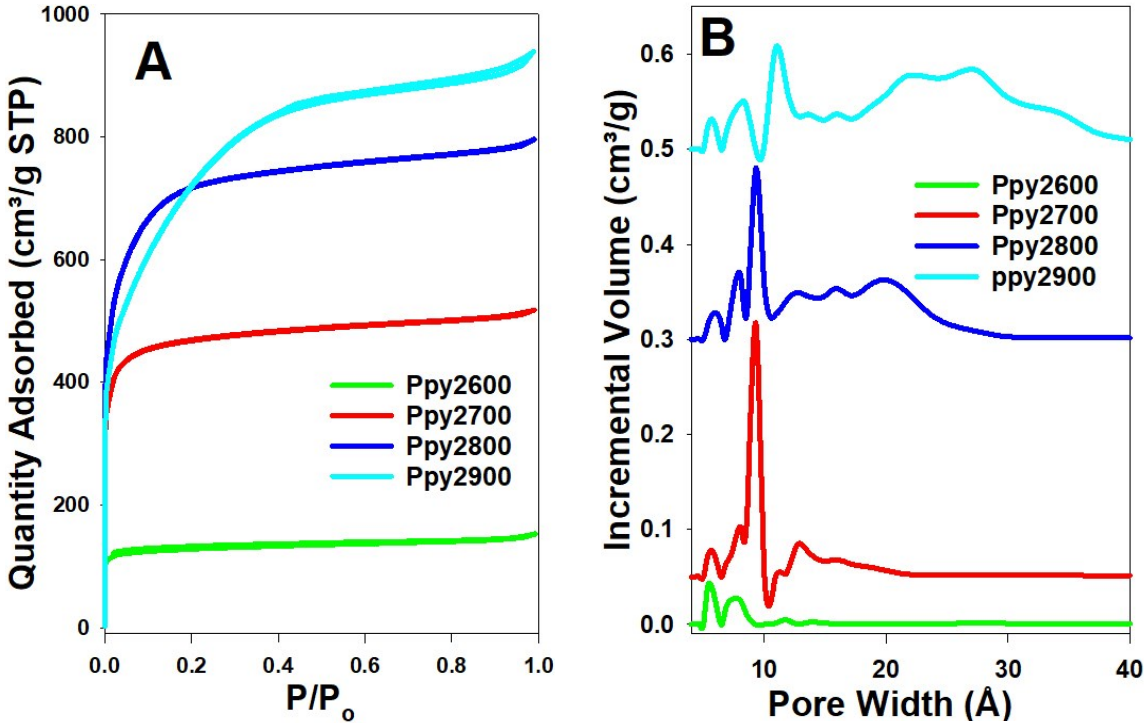
Supporting Figure S2. Powder XRD patterns of (A) samples activated at PO/SD ratio of 2, (B) samples activated at PO/SD ratio of 4 and (C) activated at 800 °C at various PO/SD ratios.



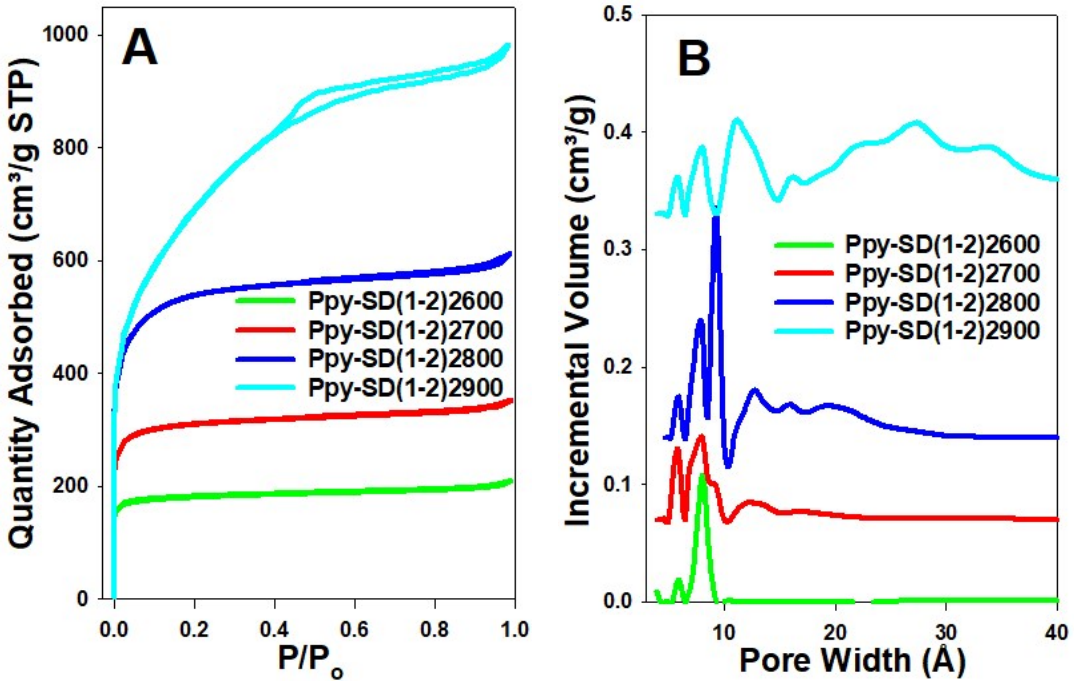
Supporting Figure S3. Pore size distributions curves for carbon samples activated at temperatures between 600 and 900 °C, and PO/SD ratio of 2 or 4.



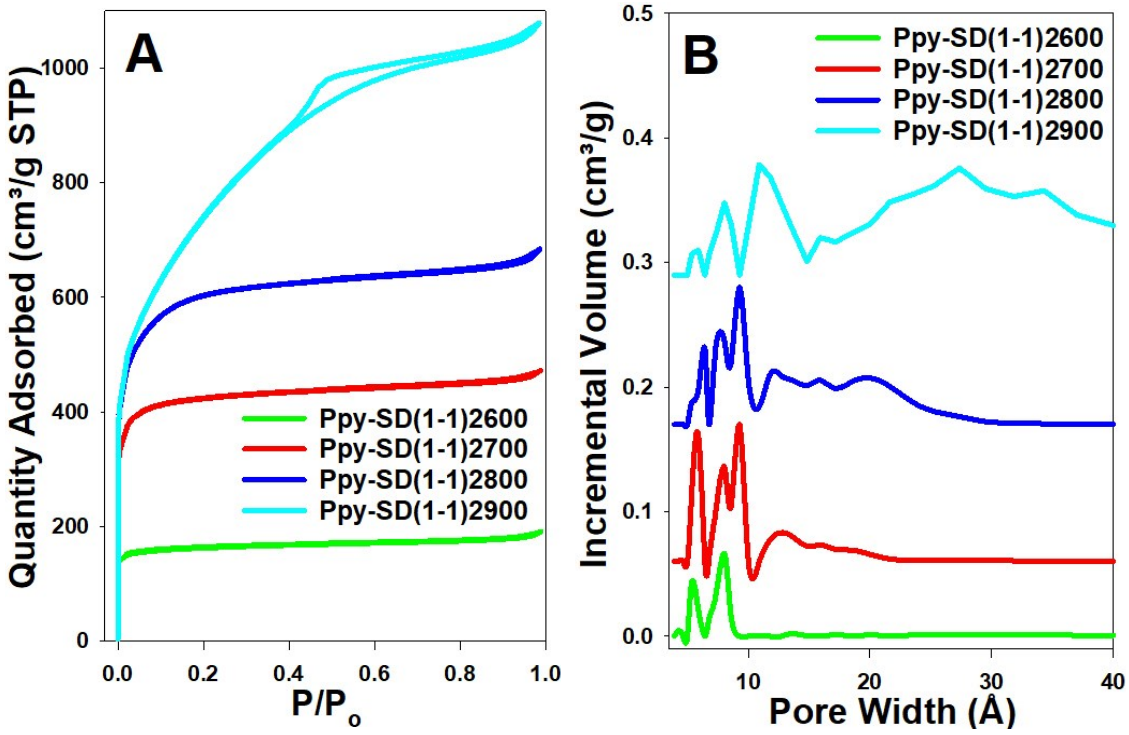
Supporting Figure S4. Carbon dioxide uptake isotherms at 25 °C and pressure of (A) 0 – 1 bar and (B) 0 – 40 bar of carbons activated at between 600 and 900 °C and PO/SD ratio of 4.



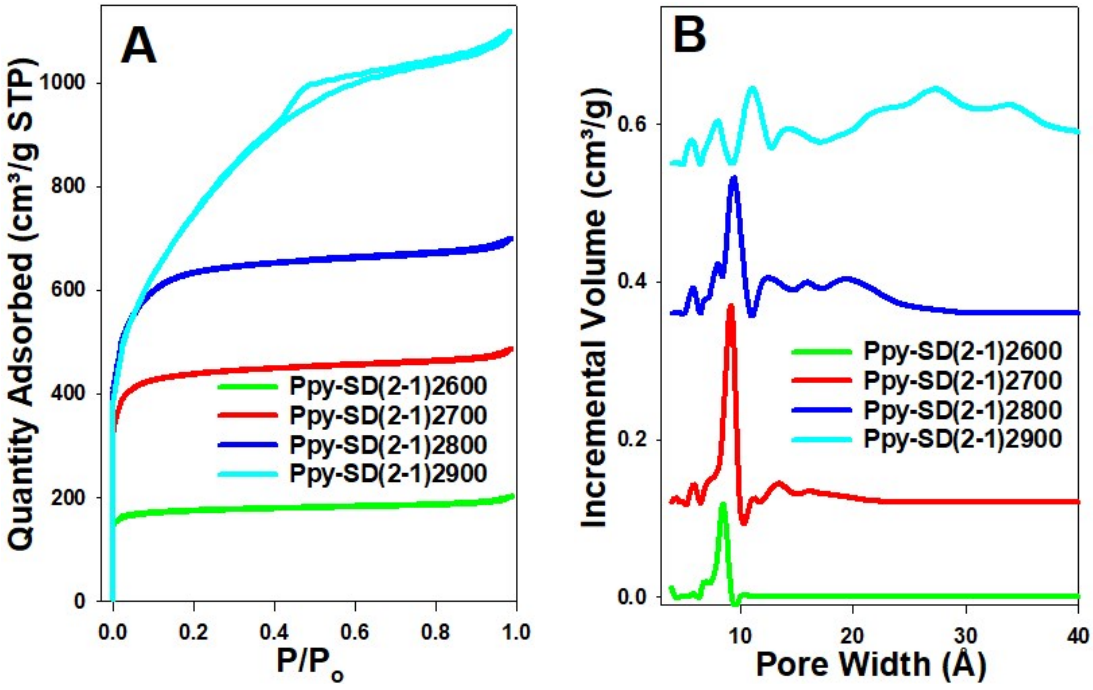
Supporting Figure S5. Nitrogen sorption isotherms (A) and pore size distribution curves (B) for polypyrrole (Ppy) derived carbons activated at 600 to 900 °C and PO/Ppy ratio of 2.



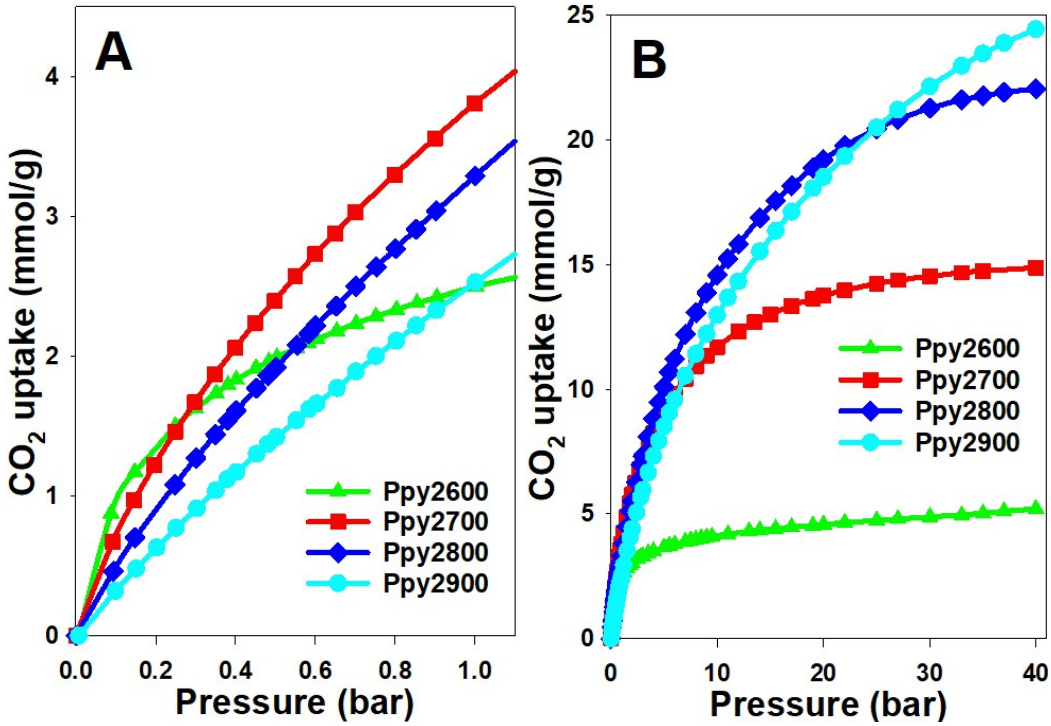
Supporting Figure S6. Nitrogen sorption isotherms (A) and pore size distribution curves (B) for carbons derived from pre-mixed precursors containing polypyrrole (Ppy) and sawdust hydrochar (SD) at Ppy:SD ratio of 1:2. The carbons were prepared at activation temperature of between 600 and 900 °C, and PO/precursor ratio of 2.



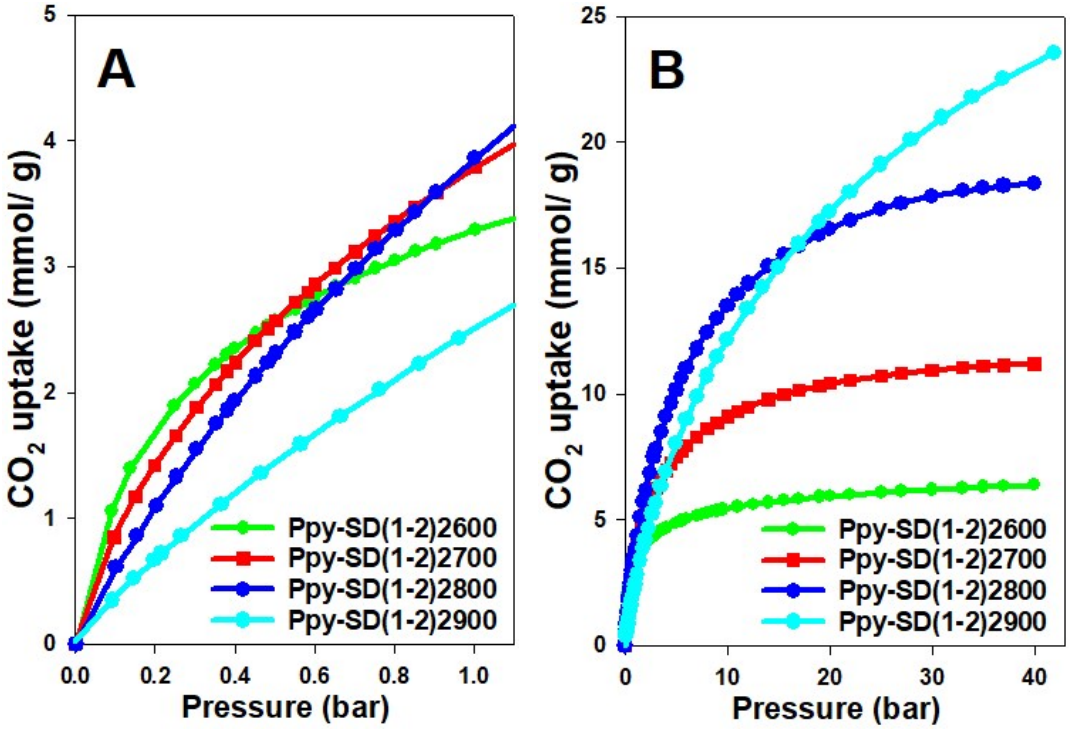
Supporting Figure S7. Nitrogen sorption isotherms (A) and pore size distribution curves (B) for carbons derived from pre-mixed precursors containing polypyrrole (Ppy) and sawdust hydrochar (SD) at Ppy:SD ratio of 1:1. The carbons were prepared at activation temperature of between 600 and 900 °C, and PO/precursor ratio of 2.



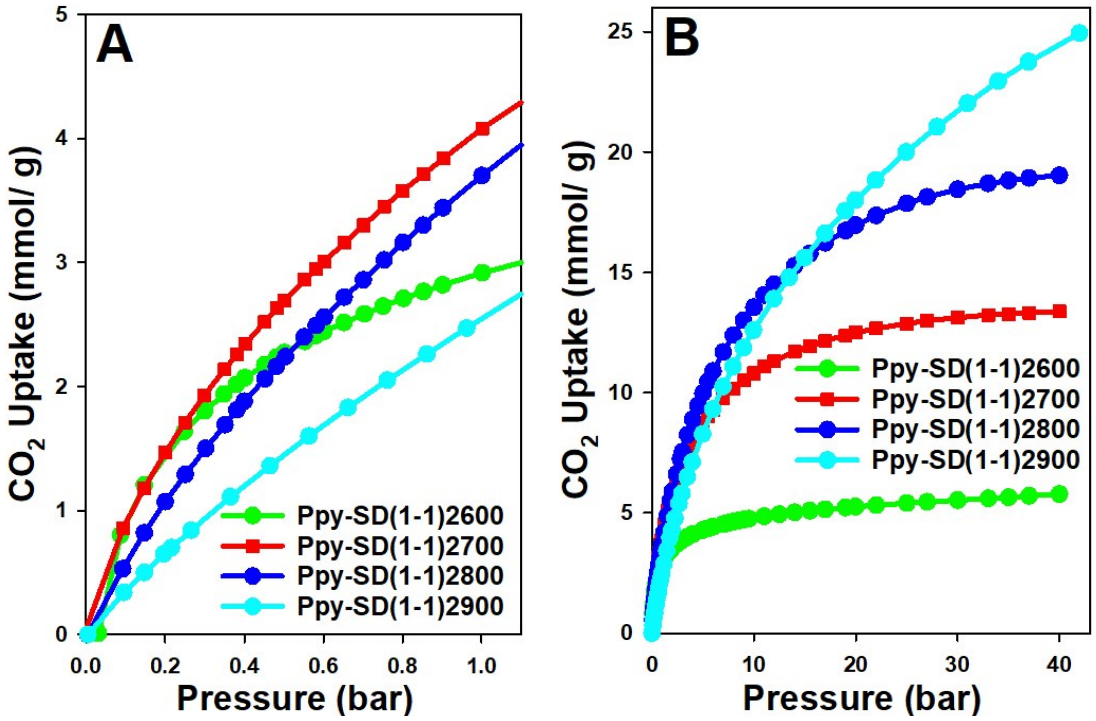
Supporting Figure S8. Nitrogen sorption isotherms (A) and pore size distribution curves (B) for carbons derived from pre-mixed precursors containing polypyrrole (Ppy) and sawdust hydrochar (SD) at Ppy:SD ratio of 2:1. The carbons were prepared at activation temperature of between 600 and 900 ^{o}C, and PO/precursor ratio of 2.



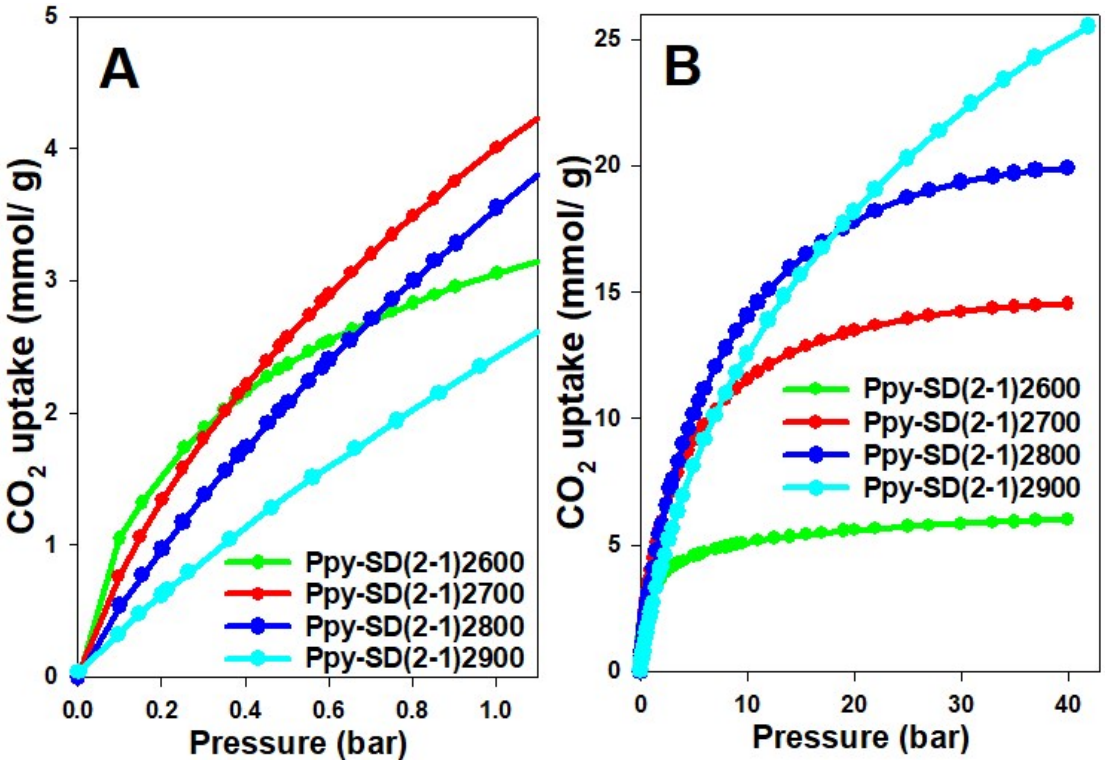
Supporting Figure S9. Carbon dioxide uptake isotherms at 25 °C and pressure of (A) 0 – 1 bar and (B) 0 – 40 bar of polypyrrole (Ppy) derived carbons activated at between 600 and 900 °C, and PO/Ppy ratio of 2.



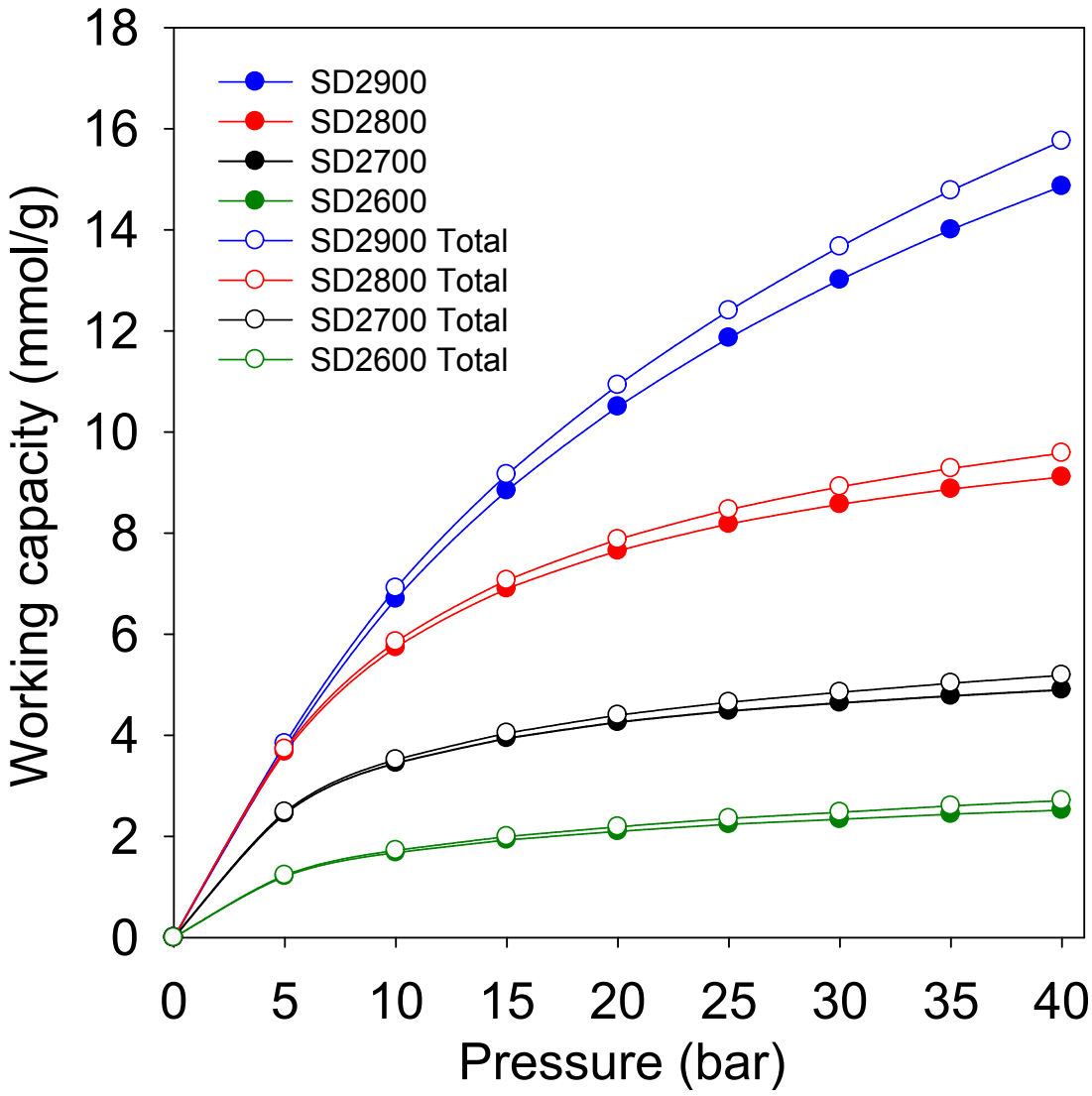
Supporting Figure S10. Carbon dioxide uptake isotherms at 25 °C and pressure of (A) 0 – 1 bar and (B) 0 – 40 bar of carbons derived from pre-mixed precursors containing polypyrrole (Ppy) and sawdust hydrochar (SD) at Ppy:SD ratio of 1:2. The carbons were prepared at activation temperature of between 600 and 900 °C, and PO/precursor ratio of 2.



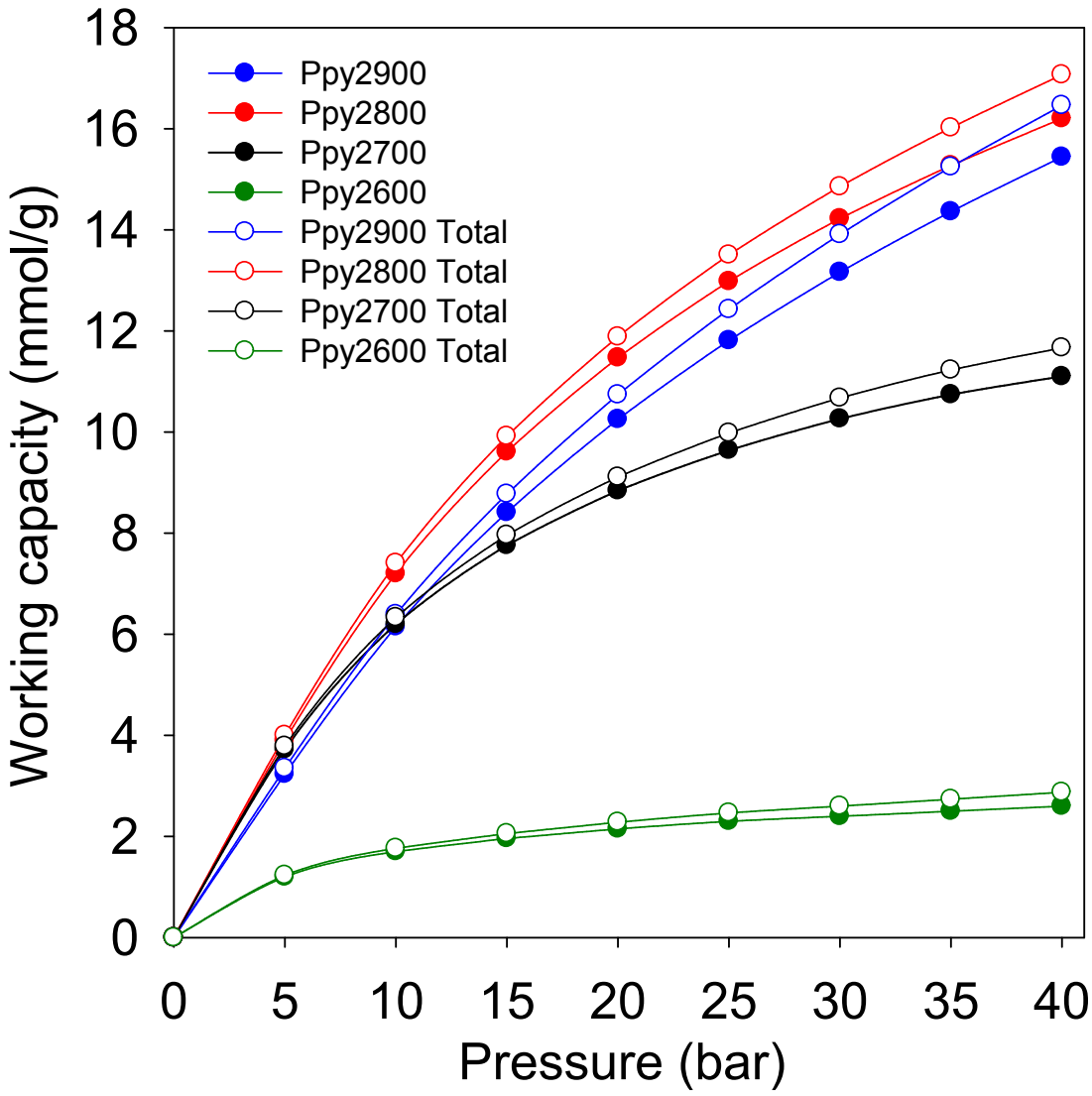
Supporting Figure S11. Carbon dioxide uptake isotherms at 25 °C and pressure of (A) 0 – 1 bar and (B) 0 – 40 bar of carbons derived from pre-mixed precursors containing polypyrrole (Ppy) and sawdust hydrochar (SD) at Ppy:SD ratio of 1:1. The carbons were prepared at activation temperature of between 600 and 900 °C, and PO/precursor ratio of 2.



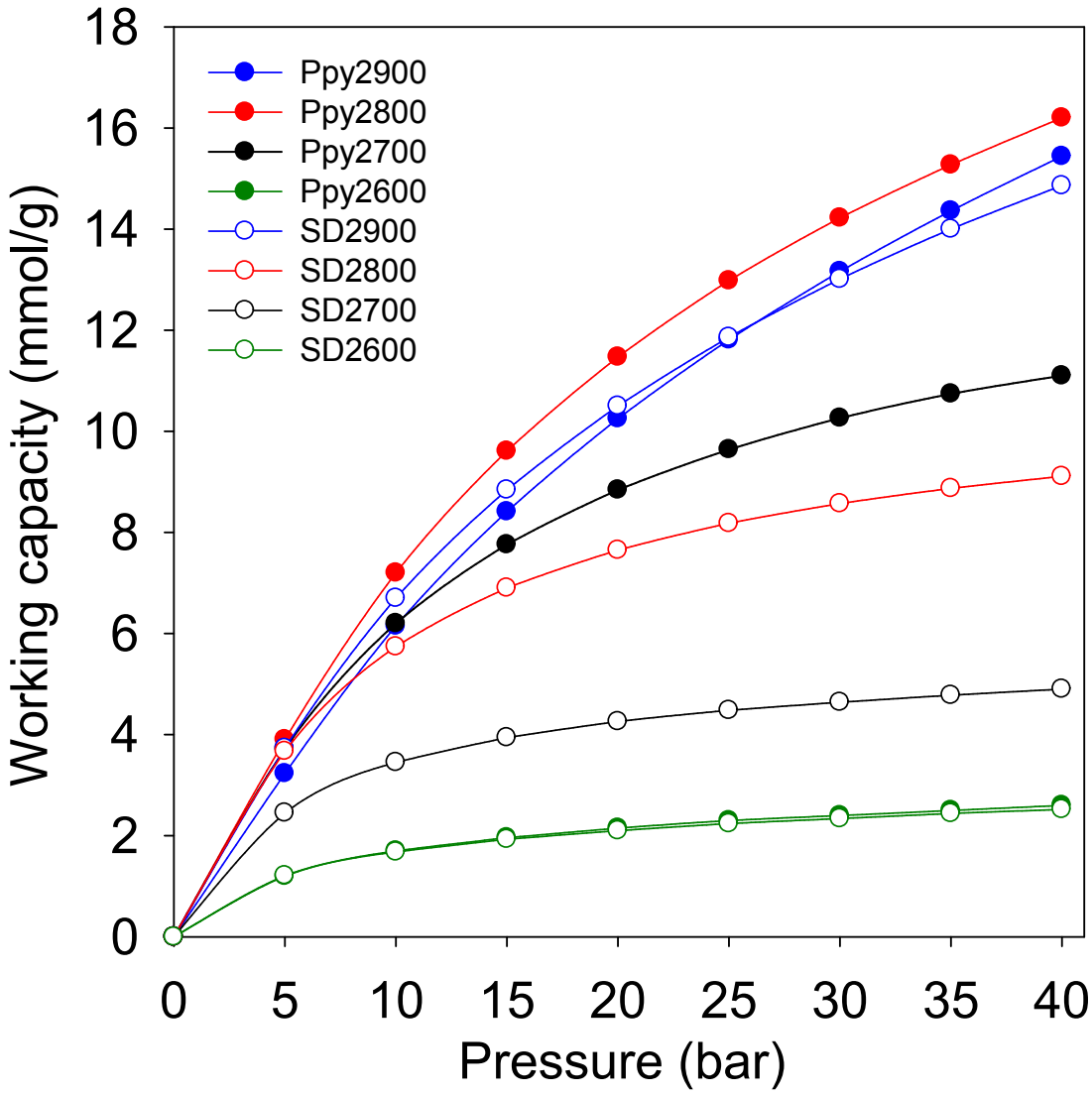
Supporting Figure S12. Carbon dioxide uptake isotherms at 25 °C and pressure of (A) 0 – 1 bar and (B) 0 – 40 bar of carbons derived from pre-mixed precursors containing polypyrrole (Ppy) and sawdust hydrochar (SD) at Ppy:SD ratio of 2:1. The carbons were prepared at activation temperature of between 600 and 900 °C, and PO/precursor ratio of 2.



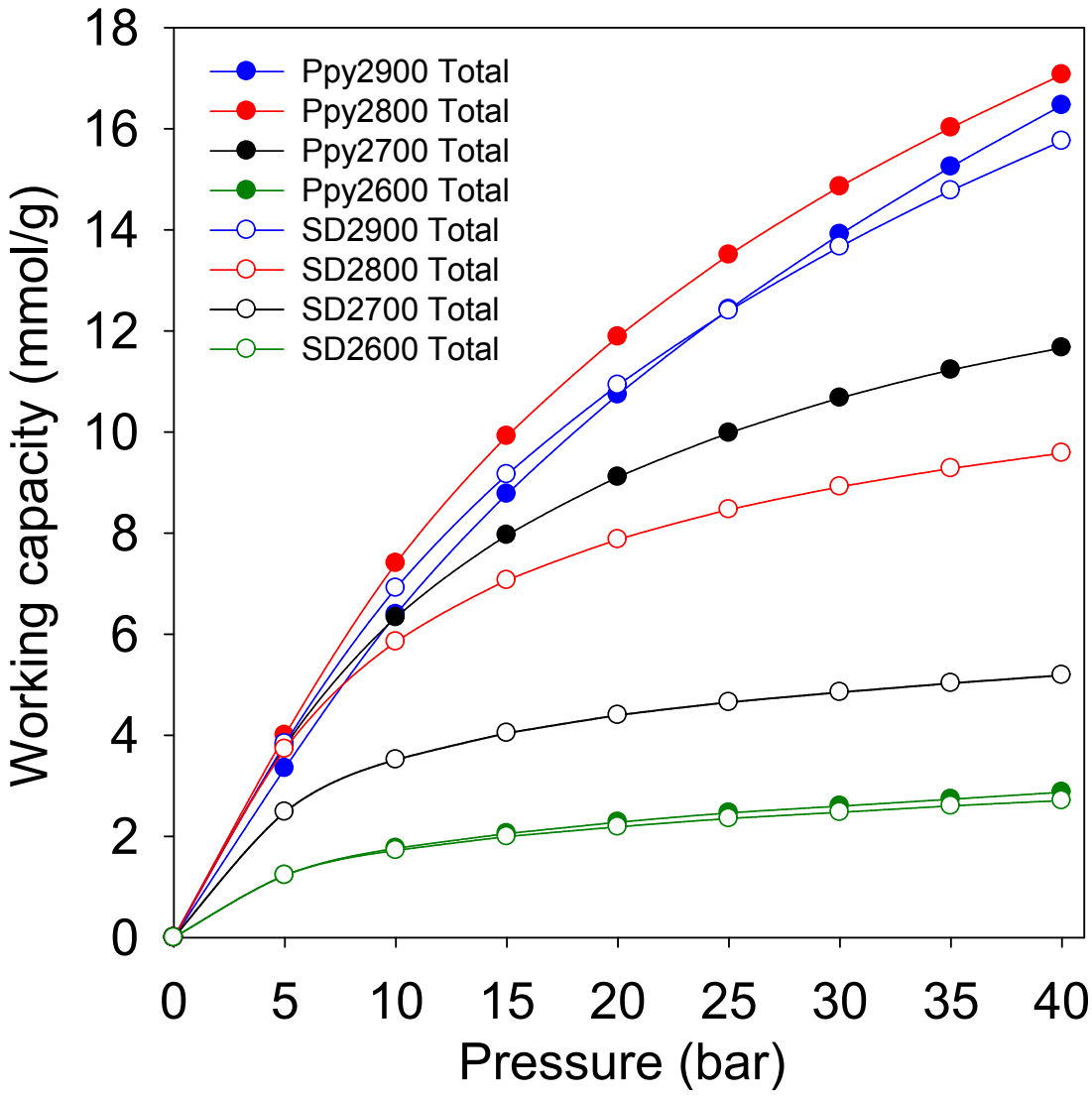
Supporting Figure S13. Excess and total pressure swing adsorption (PSA) CO_2 working capacity for a 60:40 H_2/CO_2 mixture for sawdust hydrochar (SD) derived carbons activated at between 600 and 900 ^oC, and PO/SD ratio of 2.



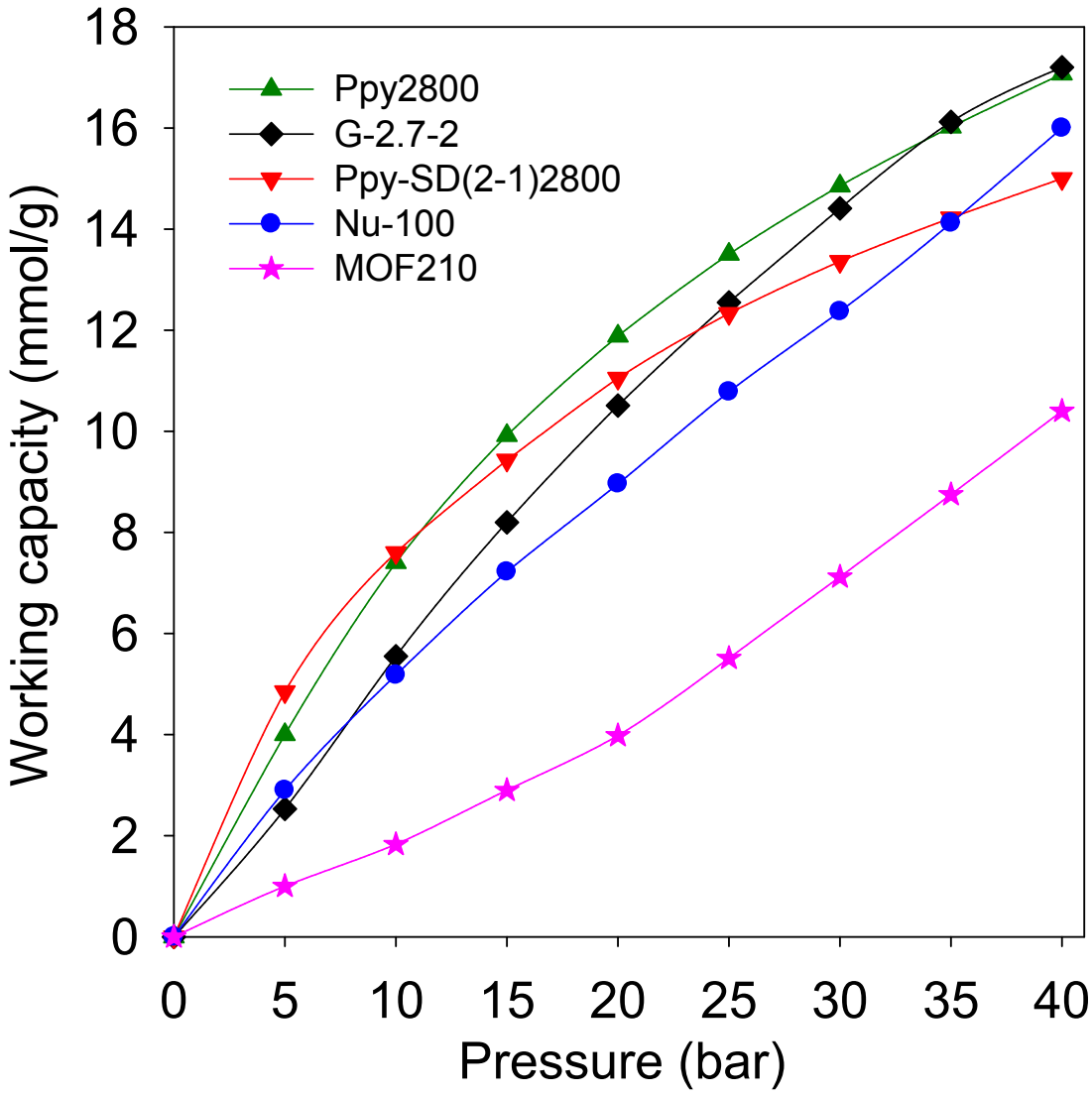
Supporting Figure S14. Excess and total pressure swing adsorption (PSA) CO_2 working capacity for a 60:40 H_2/CO_2 mixture for polypyrrole (Ppy) derived carbons activated at between 600 and 900 ^oC, and PO/SD ratio of 2



Supporting Figure S15. Excess pressure swing adsorption (PSA) CO_2 working capacity for a 60:40 H_2/CO_2 mixture for sawdust hydrochar (SD) and polypyrrole (Ppy) derived carbons activated at between 600 and 900 ^oC, and PO/SD ratio of 2.



Supporting Figure S16. Excess pressure swing adsorption (PSA) CO_2 working capacity for a 60:40 H_2/CO_2 mixture for sawdust hydrochar (SD) and polypyrrole (Ppy) derived carbons activated at between 600 and 900 ^oC, and PO/SD ratio of 2.



Supporting Figure S17. Excess pressure swing adsorption (PSA) CO_2 working capacity for a 60:40 H_2/CO_2 mixture for potassium oxalate activated carbons (Ppy2800 and Ppy-SD(2-1)2800) compared to a porous carbon (G-2.7-2) and metal organic frameworks (NU-100 and MOF210) that have much higher surface area.

Data for G-2.7-2 is from the following reference: M. Sevilla, A. M. Al-Jumialy, A. B. Fuertes and R. Mokaya, *ACS Appl. Mater. Interfaces*, 2018, **10**, 1623.

Data for NU-100 and MOF210 is from the following reference: A. R. Millward and O. M. Yaghi, *J. Am. Chem. Soc.*, 2005, **127**, 17998.