Carbonates based hyper-cross-linked polymers with pendant versatile electron-withdrawing functional groups for CO$_2$ adsorption and separation

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E-mail: bien.tan@mail.hust.edu.cn   Tel: +86-27-87558172   Fax: +86-27-87543632
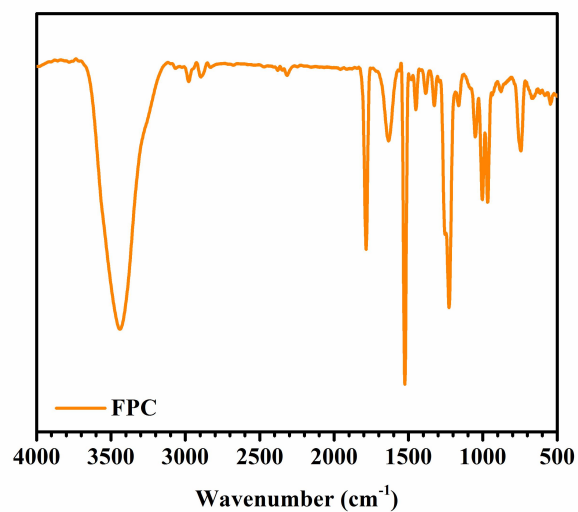
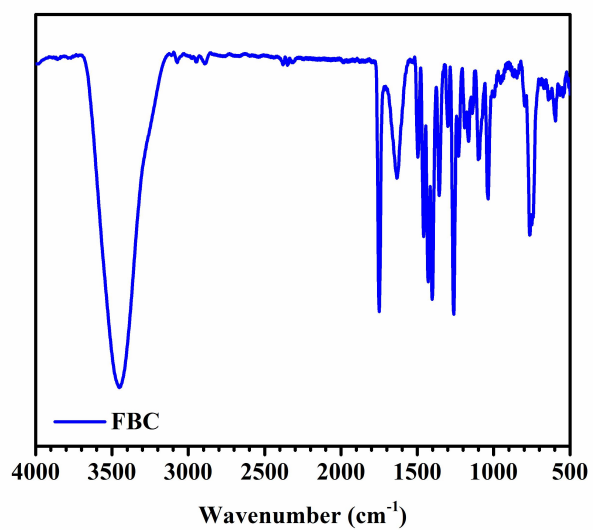**Figure S1.** Fourier transform infrared spectrum of FPC.

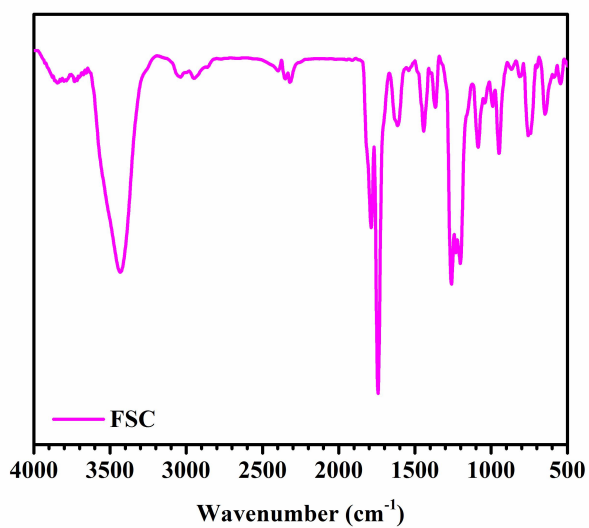**Figure S2.** Fourier transform infrared spectrum of FBC.

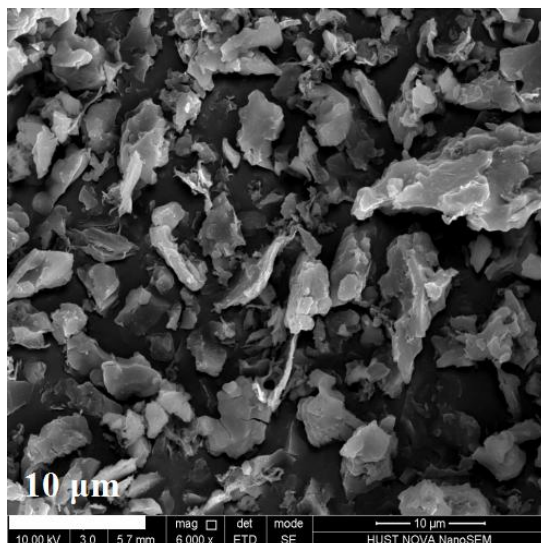**Figure S3.** Fourier transform infrared spectrum of FSC.

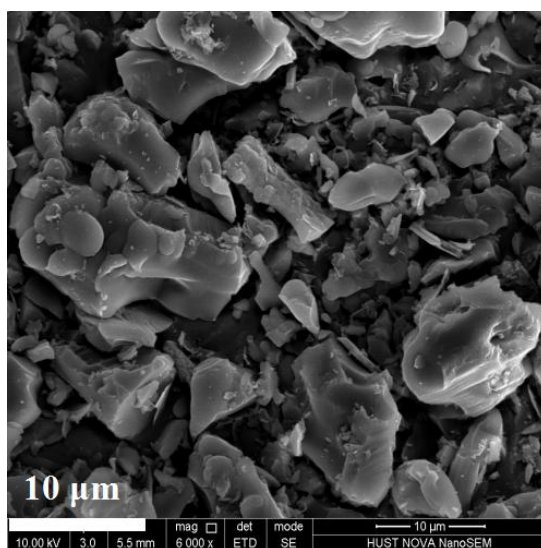**Figure S4.** SEM of FPC-based polymer **1** at a scale bar of 10 μm.

Figure S5. SEM of FBC-based polymer **2** at a scale bar of 10 μm.
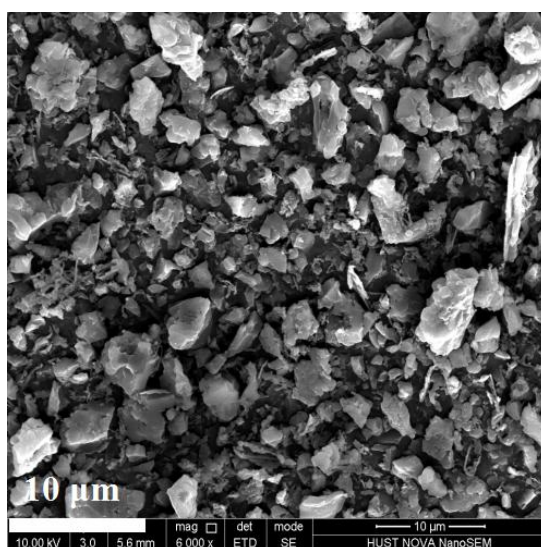

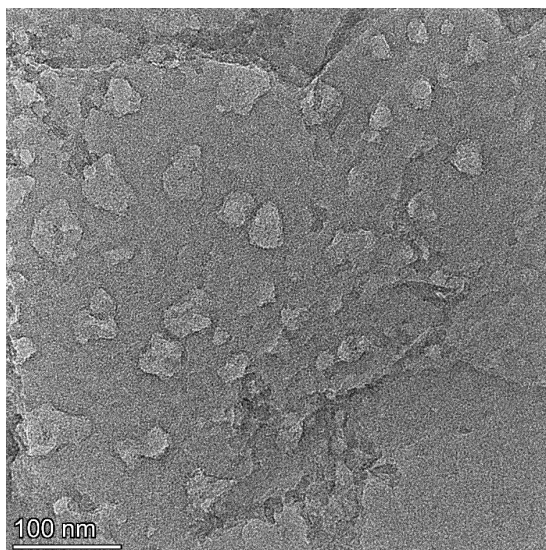**Figure S6.** SEM of FSC-based polymer **3** at a scale bar of 10 μm.

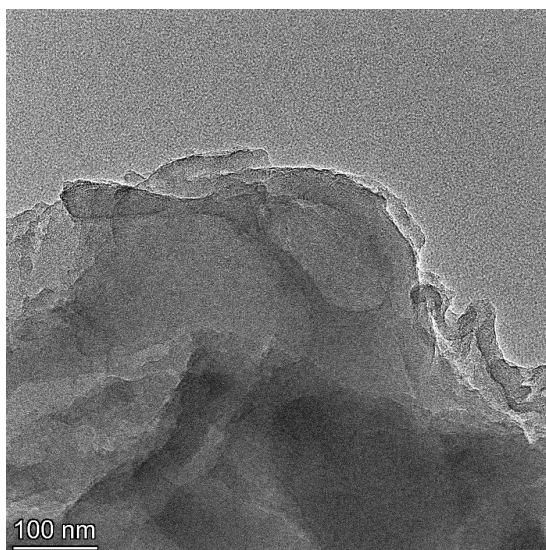**Figure S7.** TEM of FPC-based polymer **1** at a scale bar of 100 nm.

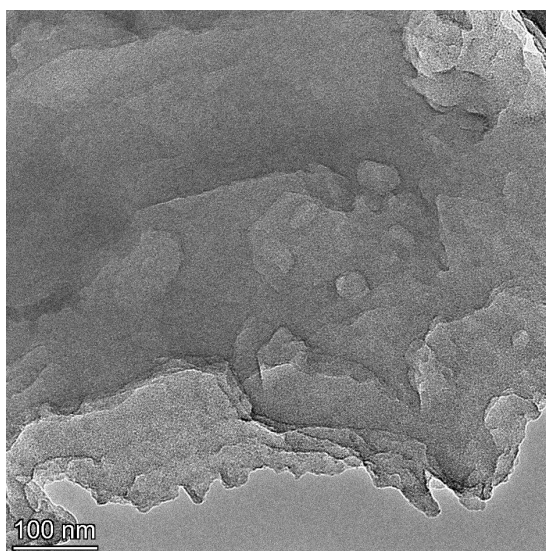**Figure S8.** TEM of FBC-based polymer **2** at a scale bar of 100 nm.

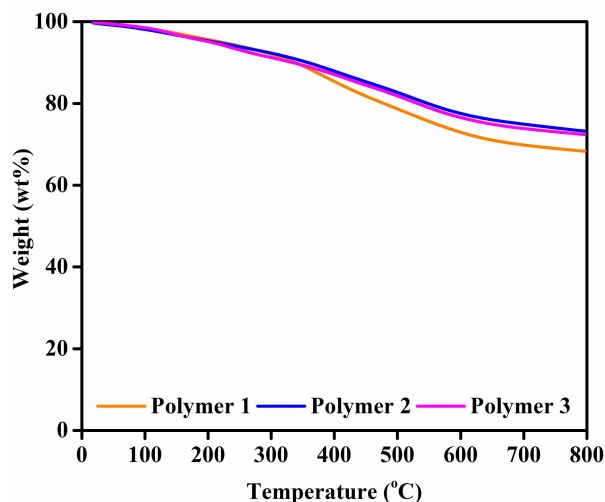**Figure S9.** TEM of FSC-based polymer **3** at a scale bar of 100 nm.

Figure S10. TGA analysis of FPC-based polymer **1**, FBC-based polymer **2** and FSC-based polymer **3**.

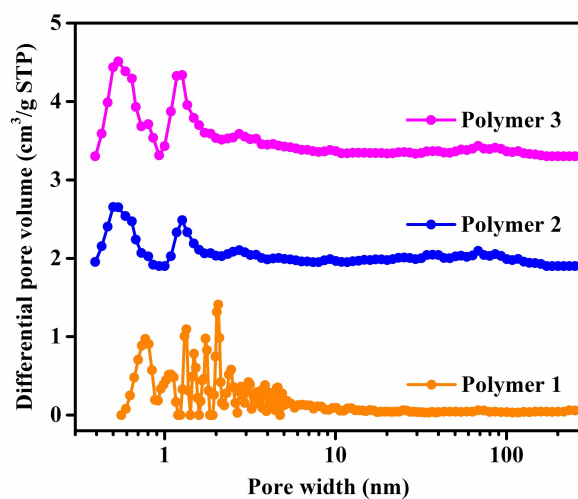**Figure S11.** Pore distribution of pore size distribution calculated using NLDFT methods (slit pore models, differential pore volumes) of generated porous organic polymers.
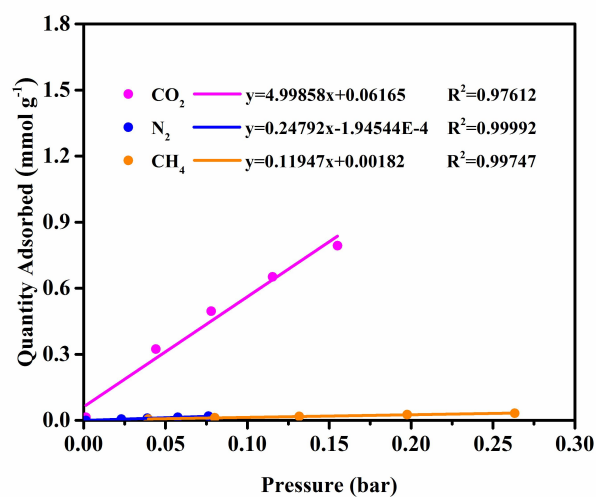

Figure S12. Adsorption selectivity of CO_2/N_2 and CO_2/CH_4 for polymer **1** calculated using Henry's law initial slope method according to their adsorption isotherms of CO_2 (pink), N_2 (blue) and CH_4 (orange) at 273.15 K.

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Figure S13. Adsorption selectivity of CO_2/N_2 and CO_2/CH_4 for polymer **2** calculated using Henry's law initial slope method according to their adsorption isotherms of CO_2 (pink), N_2 (blue) and CH_4 (orange) at 273.15 K.

Figure S14. Adsorption selectivity of CO_2/N_2 and CO_2/CH_4 for polymer **3** calculated using Henry's law initial slope method according to their adsorption isotherms of CO_2 (pink), N_2 (blue) and CH_4 (orange) at 273.15 K.
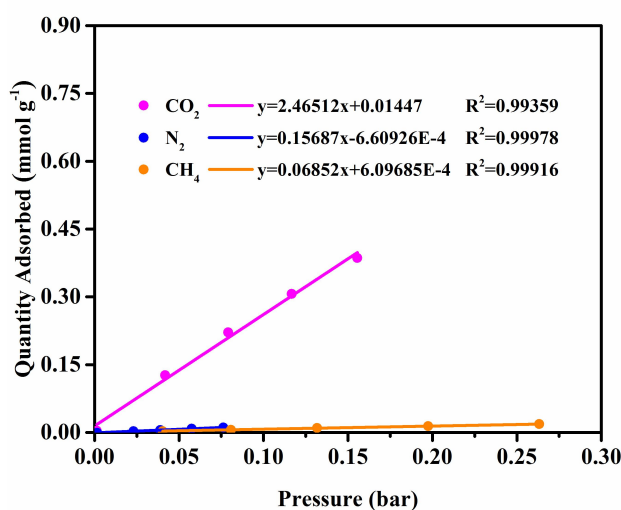
Figure S15. Adsorption selectivity of CO_2/N_2 and CO_2/CH_4 for polymer **1** calculated using Henry's law initial slope method according to their adsorption isotherms of CO_2 (pink), N_2 (blue) and CH_4 (orange) at 298.15 K.
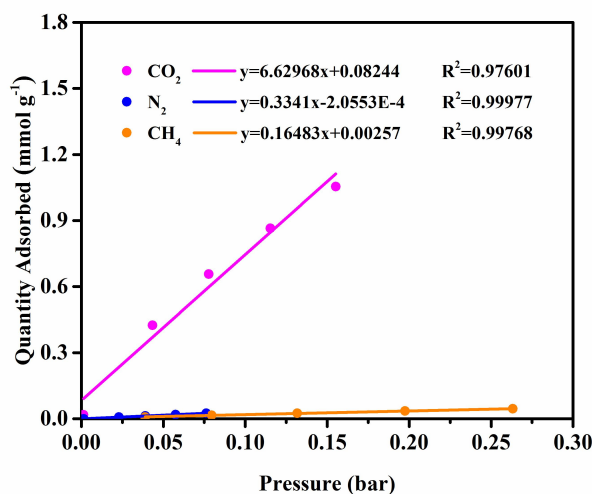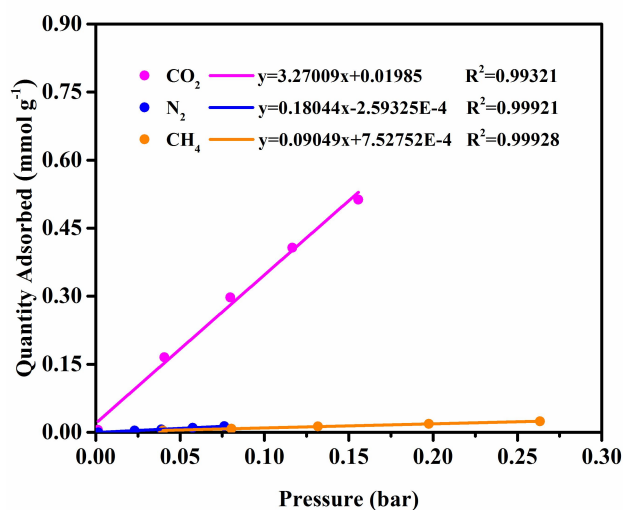
Figure S16. Adsorption selectivity of CO_2/N_2 and CO_2/CH_4 for polymer **2** calculated using Henry's law initial slope method according to their adsorption isotherms of CO_2 (pink), N_2 (blue) and CH_4 (orange) at 298.15 K.
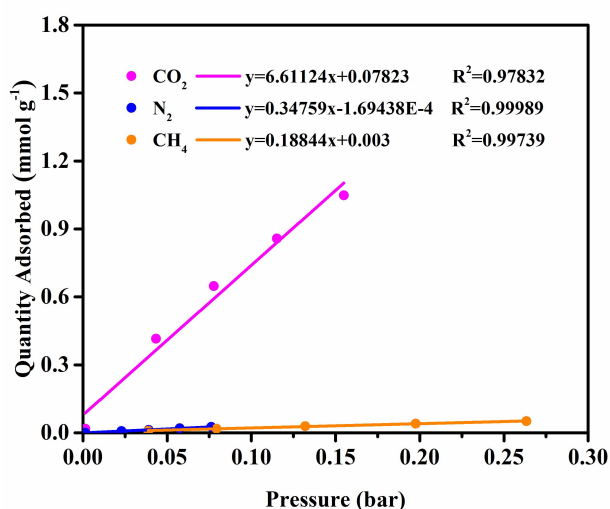

Figure S17. Adsorption selectivity of CO_2/N_2 and CO_2/CH_4 for polymer **3** calculated using Henry's law initial slope method according to their adsorption isotherms of CO_2 (pink), N_2 (blue) and CH_4 (orange) at 298.15 K.
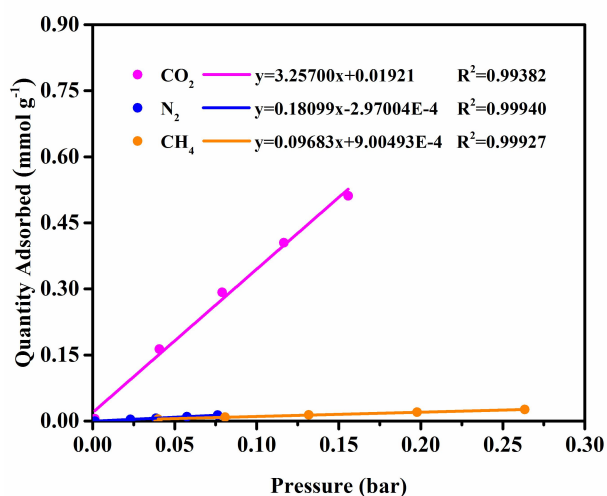
Table S1. The content of different elements for porous hyper-cross-linked polymers based on the elemental analysis and parent building blocks by theoretical calculation according to Equation S2.

Samples	C (%)	H (%)	O (%)	N (%)	F (%)
FPC	62.07	2.71	11.82	0.00	23.40
polymer **1**	60.11	2.34	9.28	0.00	20.77
FBC	70.59	4.20	13.45	11.76	0.00
polymer **2**	68.43	3.88	11.64	10.25	0.00
FSC	67.66	4.45	23.74	4.15	0.00
polymer **3**	65.81	4.04	21.46	3.89	0.00

$$Yield\ \% = \frac{m_1\ (g)}{m_2\ (g)} \times 100\% \qquad (1)$$

Where m_1 is the weight of polymer **1**, polymer **2** and polymer **3** measured respectively after drying in a vacuum oven at 70 °C for 48 h, m_2 is the weight of FPC, FBC and FSC correspondingly.

Equation S1   The yield estimation of polymer **1**, polymer **2** and polymer **3**.

$$N\ \% = \frac{n \times Ar\ (N)}{Mr\ (M)} \times 100\% \qquad (2)$$

Where Mr (M) is the relative molecular mass of a monomer molecule, n is the number of one element atom in a monomer molecule, Ar (N) is the relative atom mass of corresponding element atom.

Equation S2   The element content estimation of a monomer molecule.