Supporting Information

Mesoporous silica-carbon composites fabricated by a universal strategy of hydrothermal carbonization: controllable synthesis and applications

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Figure S1

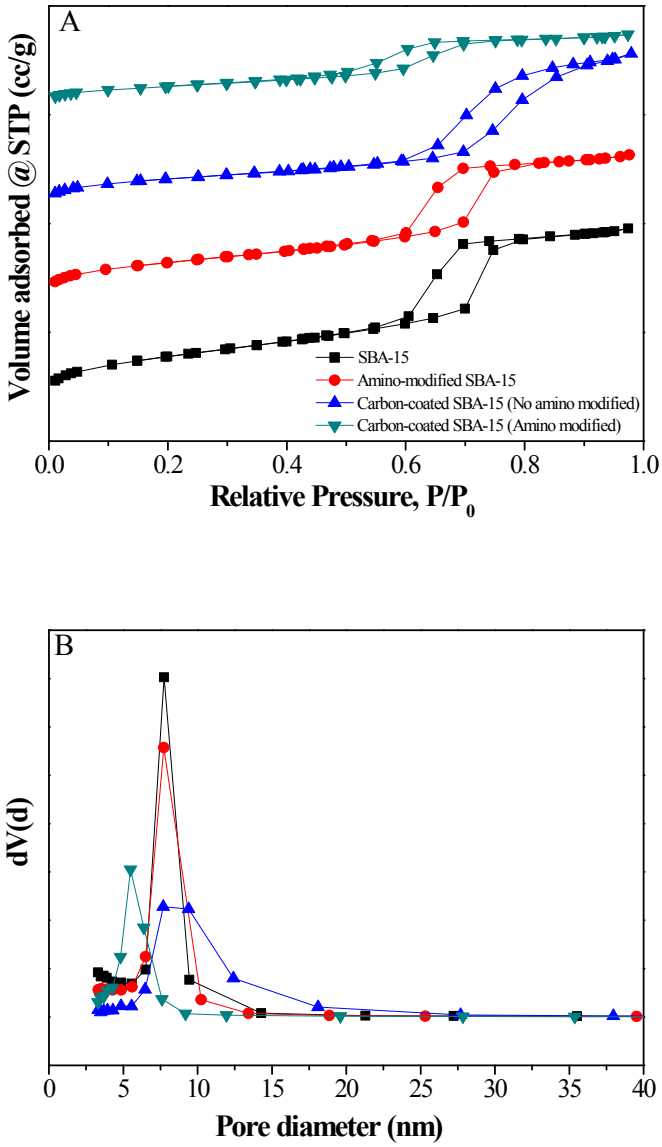


Fig. S1 Nitrogen adsorption/desorption isotherms (A) and pore size distributions (B) of SBA-15, SBA-15-NH_2 and carbon-coated SBA-15 (amino modified and no amino-modified).

Figure S2

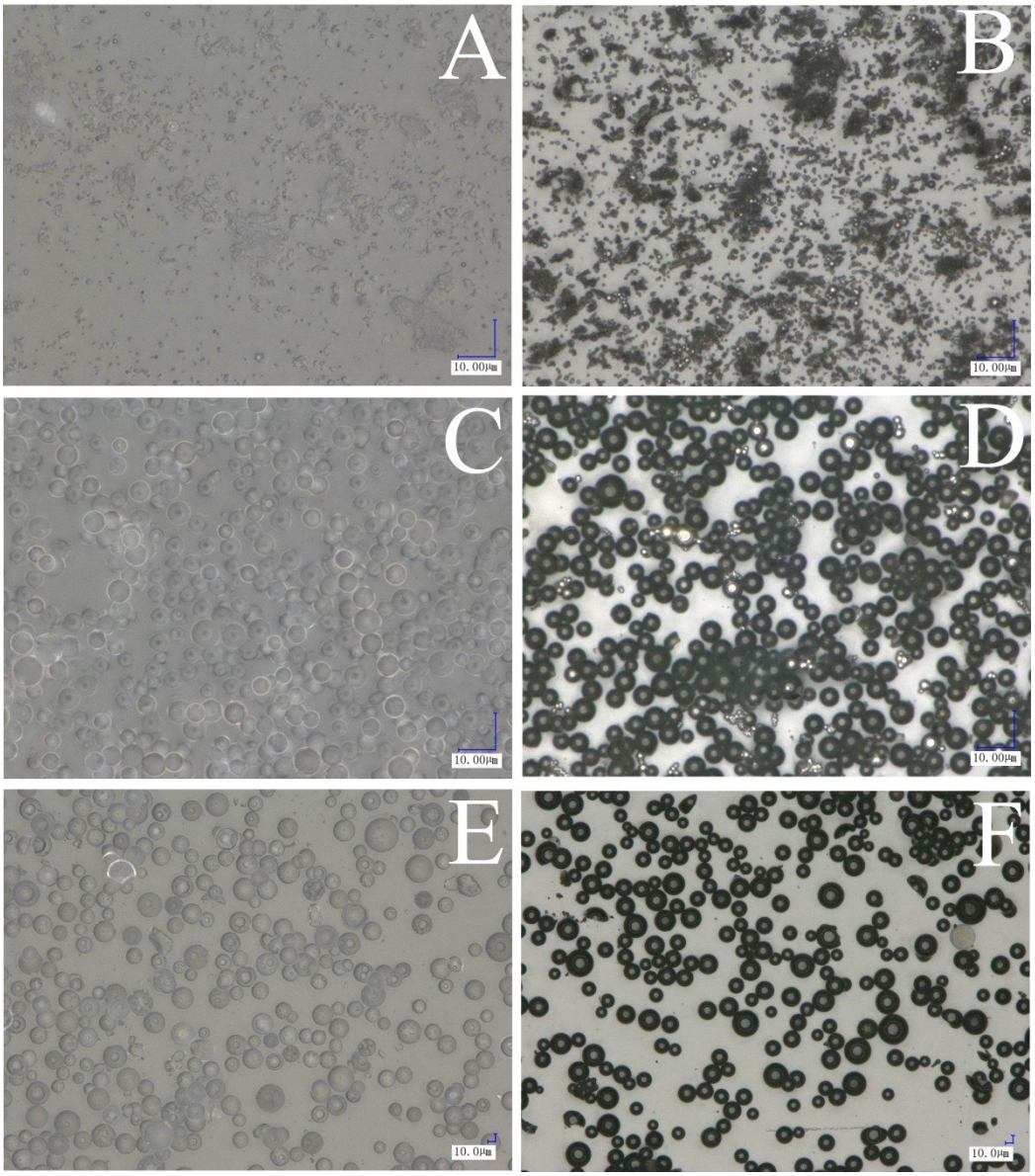


Fig. 2 The optical microscope images of SBA-15 (A, before; B, after) and spherical silica gels with particle sizes of 5 (C, before; D, after) and 30 μm (E, before; F, after) before and after the coating of carbon layer, and the scale bars were 10 μm.

Figure S3

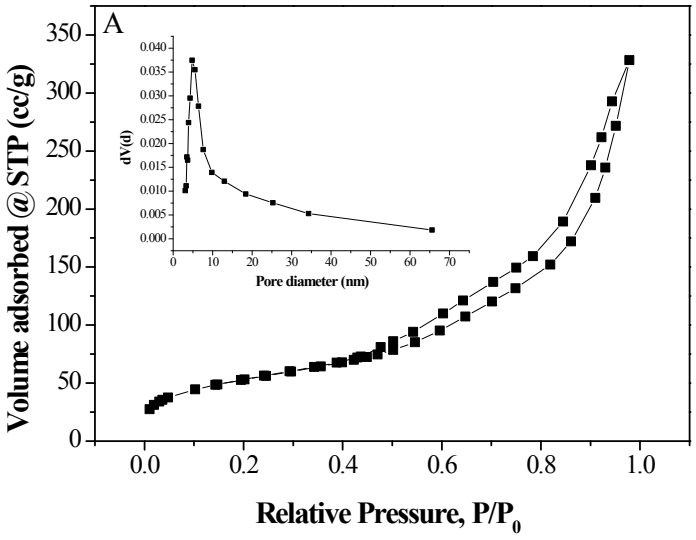


Fig. S3 Nitrogen adsorption/desorption isotherm of SBA-15-C at the SBA-15/glucose ratio of 1:0.1, the insert shows the pore size distribution.

Figure S4

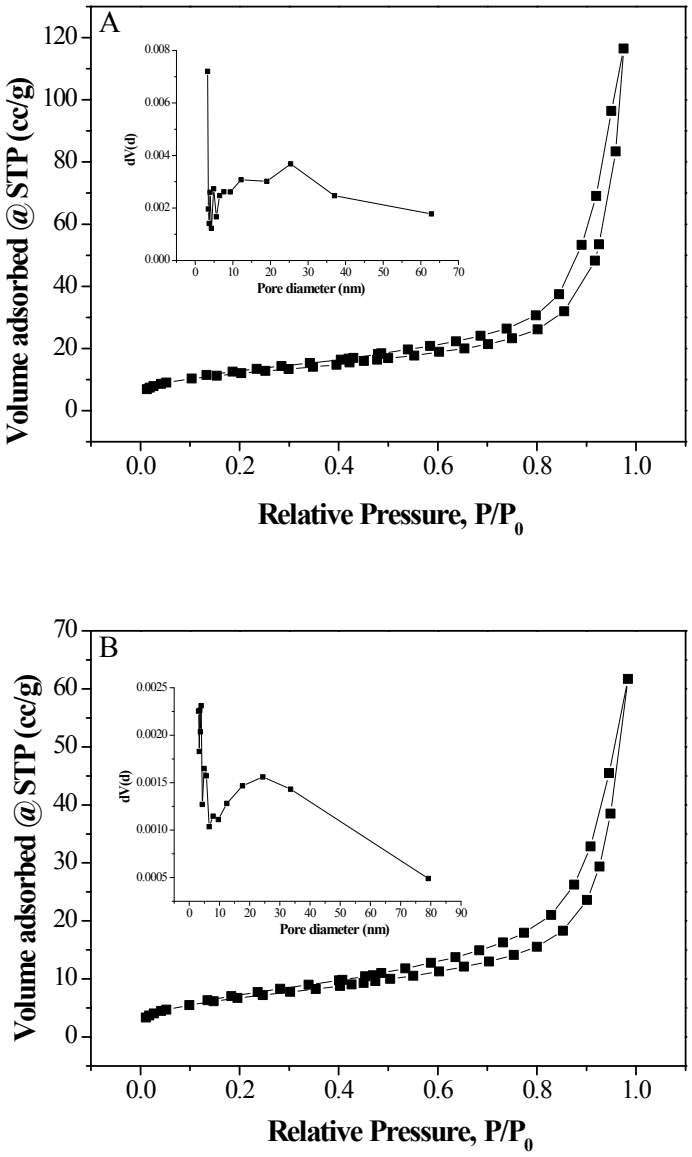


Fig. S4 Nitrogen adsorption/desorption isotherms of SBA-15 (A) and SBA-15-NH_2 (B) after hydrothermal treatment, the insert shows the pore size distributions of the corresponding samples.

Figure S5

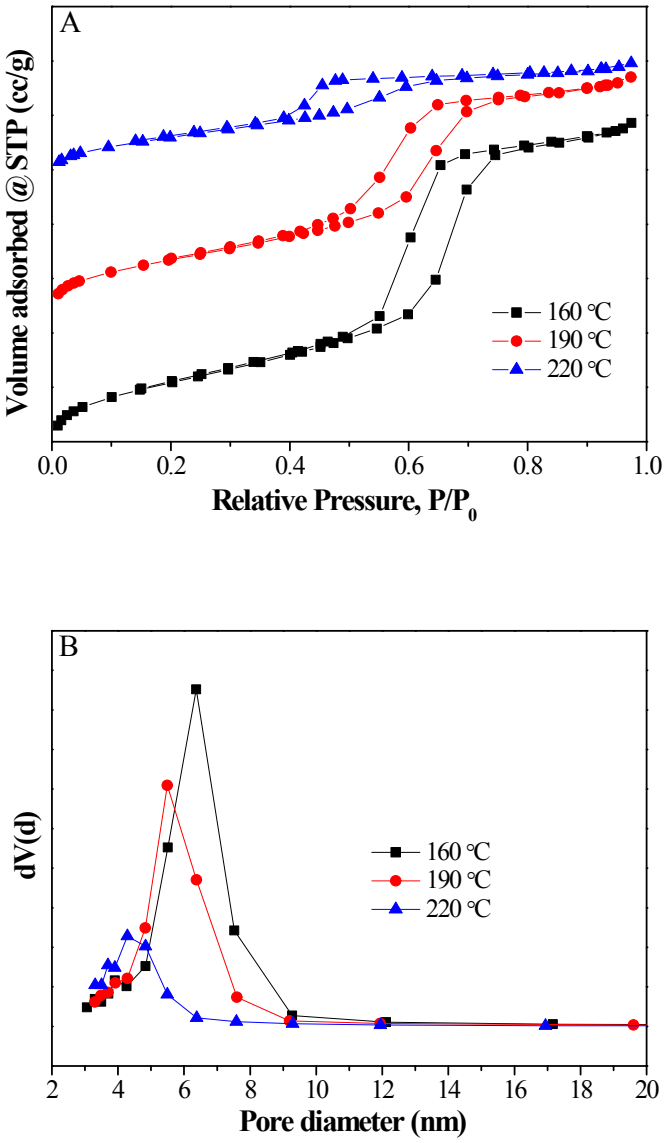


Fig. S5 Nitrogen adsorption/desorption isotherms (A) and pore size distributions (B) of SBA-15-C at different hydrothermal treatment temperature.

Figure S6

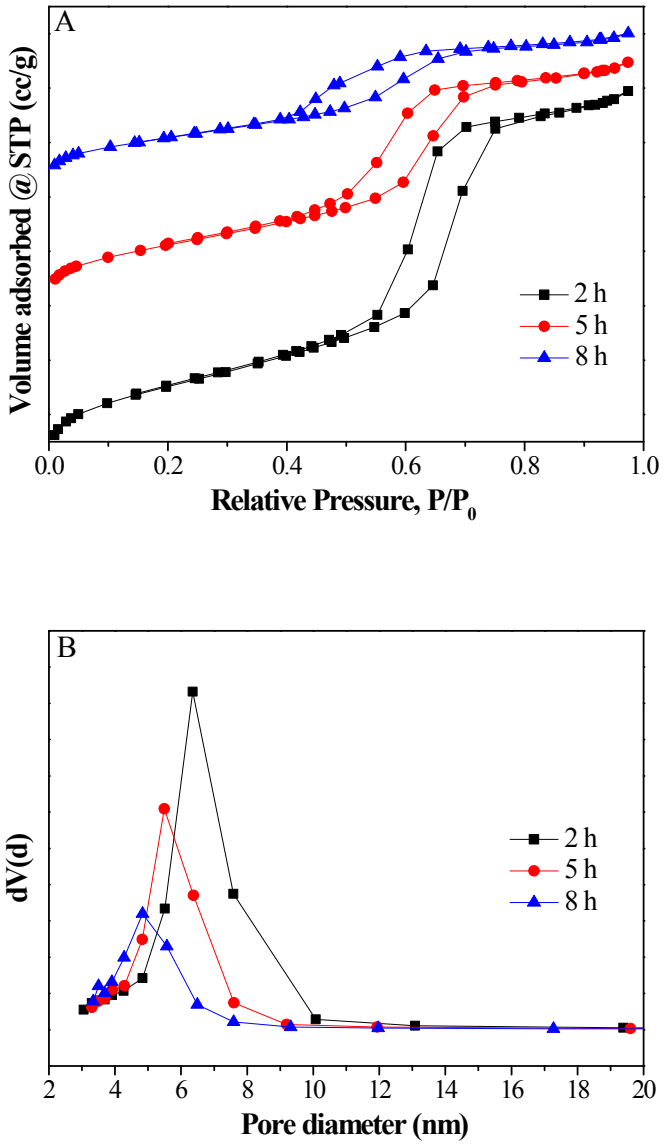


Fig. S6 Nitrogen adsorption/desorption isotherms (A) and pore size distributions (B) of SBA-15-C at different hydrothermal treatment time.

Figure S7

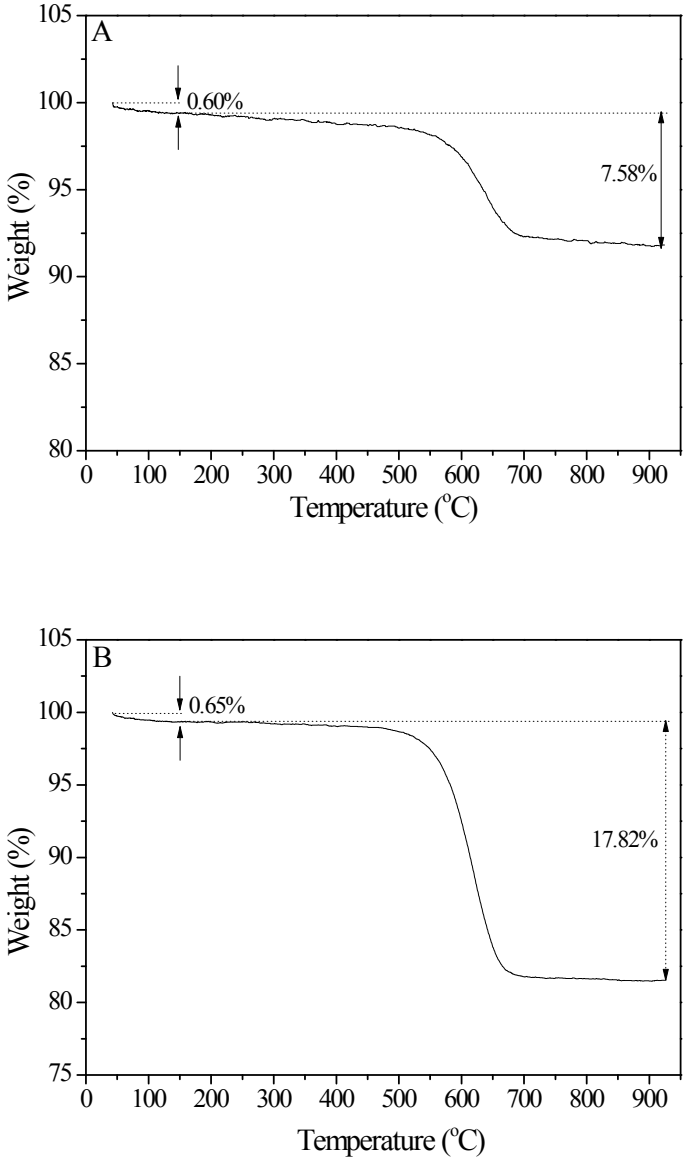


Fig. S7 TGA curves of (A) SBA-15-C(1:0.5) and (B) SiO_2-C(30 μm).

Figure S8

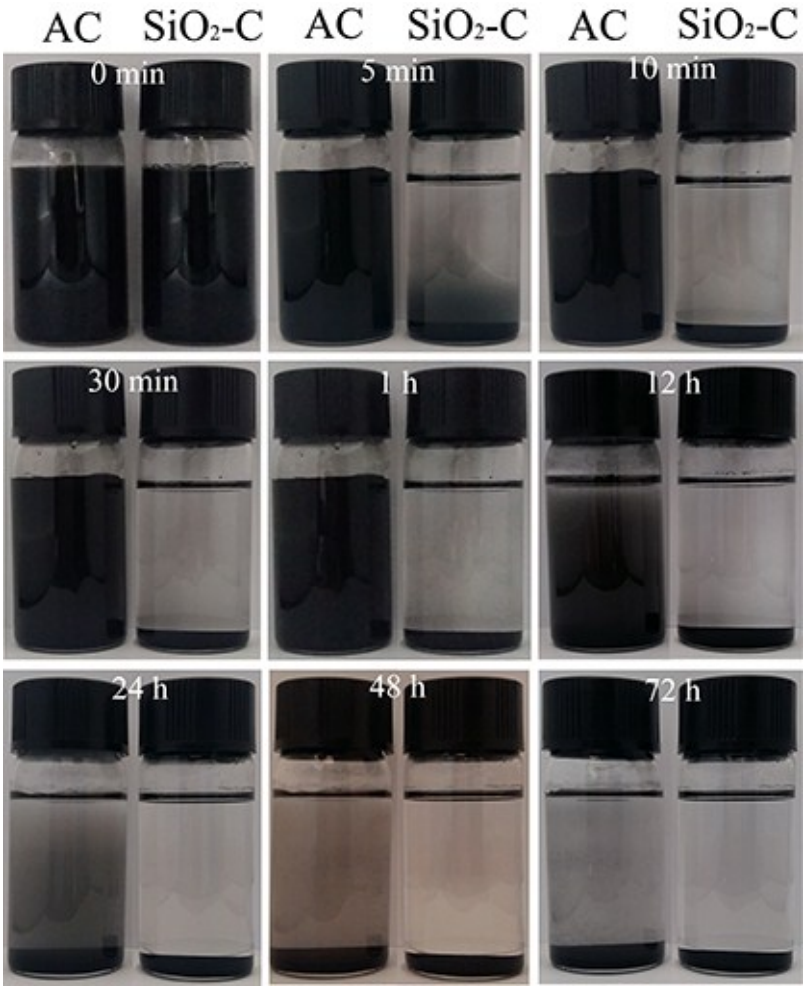


Fig. S8 The images of sedimentation of SiO_2-C(30 μm) at different time.

Figure S9

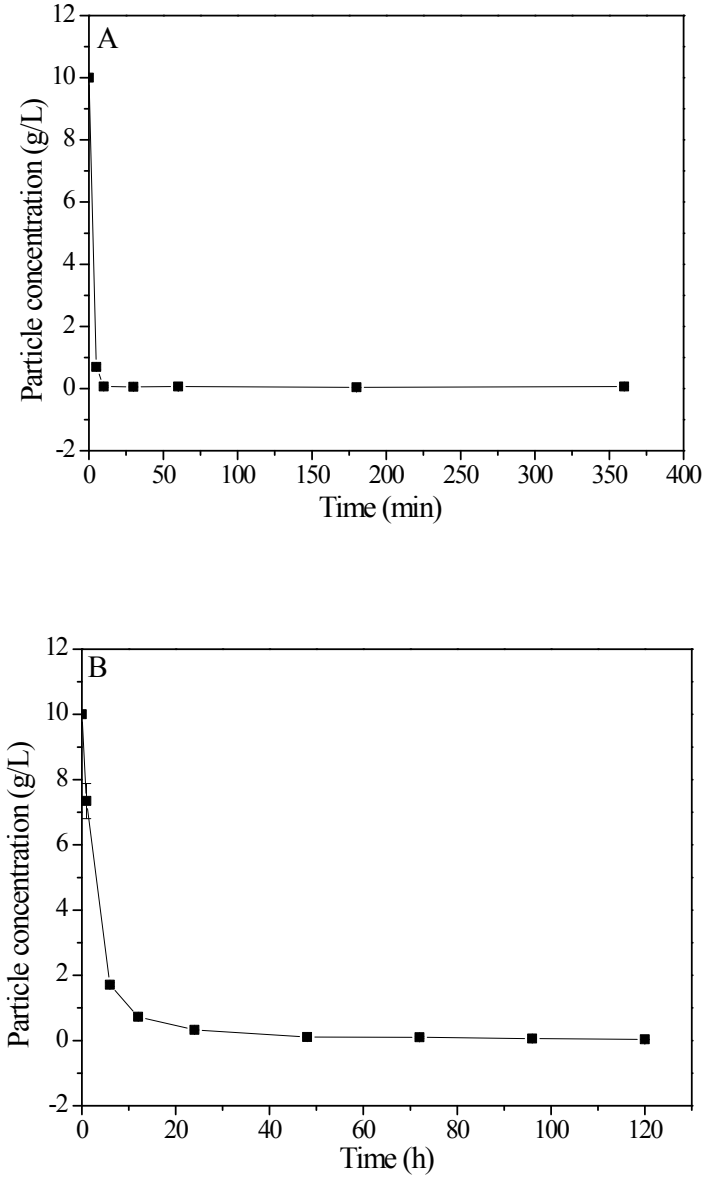


Fig. S9 Sedimentation of (A) SiO_2-C(30 μm) and (B) activated carbon in aqueous solution, the samples were collected from the middle of the beakers.

Table S1

Table S1 Textual properties and elemental analysis of samples

Samples	S_{BET} (m^2/g)	S_{mic} [a] (m^2/g)	S_{meso} [b] (m^2/g)	V_t (cm^3/g)	V_{mic} [a] (cm^3/g)	V_{meso} [b] (cm^3/g)	d_{BJH} (nm)	C (wt%)	N (wt%)	H (wt%)	Carbon layer content (wt%)	Silica content (wt%)
SBA-15	614	92	522	0.90	0.04	0.86	7.74	1.09	0.083	1.08	—	—
SBA-15-NH_2	434	14	420	0.72	0.00	0.72	7.72	4.27	1.72	1.51	—	—
SBA-15-C (1:0.1) [c]	191	20	171	0.51	0.01	0.50	4.81	0.61	0.17	0.00	—	—
SBA-15-C (1:0.5) [c]	331	49	282	0.62	0.02	0.60	6.39	5.76	0.47	0.08	7.58	91.82
SBA-15-C (1:1) [c]	297	40	257	0.48	0.02	0.46	6.49	11.71	0.48	0.56	20.78	77.19
SBA-15-C (1:3) [c]	326	77	249	0.40	0.04	0.36	5.49	23.46	0.67	0.66	32.20	65.39
SBA-15-C (1:5) [c]	356	146	210	0.32	0.06	0.26	4.82	29.88	0.50	1.11	36.68	61.44
SBA-15-C (1:7) [c]	342	131	211	0.32	0.06	0.26	4.87	31.53	0.52	0.75	39.51	57.45
SBA-15-C(160 °C) [d]	330	35	295	0.51	0.02	0.49	6.37	7.63	0.42	0.35	16.49	81.87
SBA-15-C(220 °C) [d]	346	170	176	0.26	0.07	0.19	4.28	28.36	0.64	0.79	37.80	59.35
SBA-15-C(2 h) [e]	382	55	327	0.59	0.02	0.57	6.35	10.65	0.58	0.16	18.52	79.59
SBA-15-C(8 h) [e]	392	201	191	0.32	0.09	0.23	4.83	32.80	0.60	0.68	39.74	57.15
SBA-15-C (400 °C) [f]	415	191	224	0.41	0.09	0.32	5.53	26.90	0.81	1.52	43.43	52.60
SBA-15-C (600 °C) [f]	455	200	255	0.46	0.09	0.37	5.52	22.53	0.77	1.13	32.82	63.96
SiO_2-C (5 μm) [g]	286	80	206	0.53	0.04	0.49	9.16	18.37	0.40	0.42	21.19	77.48
SiO_2-C (30 μm) [h]	286	109	177	0.45	0.05	0.40	9.29	15.13	0.54	0.35	17.82	81.53
SBA-15-C(1:3) [i] No amino modification	432	152	280	0.81	0.07	0.74	7.69	—	—	—	—	—
SBA-15-C(1:3) eluted by NaOH	758	167	591	0.58	0.08	0.50	3.69	—	—	—	—	—
SBA-15 [j] (Hydrothermal treatment)	43	—	—	0.18	—	—	3.29	—	—	—	—	—
SBA-15-NH_2 [j] (Hydrothermal treatment)	25	—	—	0.10	—	—	3.95	—	—	—	—	—
SBA-15-HC(1:5) [k]	121	16	105	0.13	0.01	0.12	4.28	—	—	—	—	—
SBA-15-HC(1:7) [k]	82	12	70	0.08	0.01	0.07	4.31	—	—	—	—	—

[a] Micropore surface area (S_{mic}) and volume (V_{micro}) obtained using the t-plot method; [b] Mesopore surface area (S_{meso}) and volume (V_{meso}) obtained using: $S_{meso}=S_{BET}-S_{mic}$, $V_{meso}=V_t-V_{mic}$; [c] Preparation conditions: hydrothermal treatment temperature, 190 °C; hydrothermal treatment time, 5 h; the mass ratio of SBA-15 to glucose, 1:0.1-1:7; calcination temperature, 800 °C and calcination time, 3 h; [d]

Preparation conditions: hydrothermal treatment temperature, 160 and 220 °C; hydrothermal treatment time, 5 h; the mass ratio of SBA-15 to glucose, 1:3; calcination temperature, 800 °C and calcination time, 3 h; [e] Preparation conditions: hydrothermal treatment temperature, 190 °C; hydrothermal treatment time, 2 and 8 h; the mass ratio of SBA-15 to glucose, 1:3; calcination temperature, 800 °C and calcination time, 3 h; [f] Preparation conditions: hydrothermal treatment temperature, 190 °C; hydrothermal treatment time, 5 h; the mass ratio of SBA-15 to glucose, 1:3; calcination temperature, 400 and 600 °C and calcination time, 3 h; [g] Preparation conditions: hydrothermal treatment temperature, 190 °C; hydrothermal treatment time, 5 h; the mass ratio of SiO_2 to glucose, 1:3; calcination temperature, 800 °C and calcination time, 3 h; [h] Preparation conditions: hydrothermal treatment temperature, 190 °C; hydrothermal treatment time, 8 h; the mass ratio of SiO_2 to glucose, 1:1; calcination temperature, 800 °C and calcination time, 3 h; [i] Sample prepared from no amino-modified SBA-15; [j] SBA-15 and amino-modified SBA-15 (SBA-15-NH_2) treated under 190 °C with no adding of glucose; [k] Hydrothermal carbon layer-coated SBA-15 (SBA-15-HC) with the SBA-15/glucose ratios of 1:5 and 1:7.

Table S2

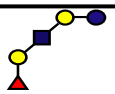
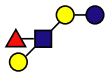
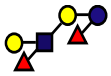
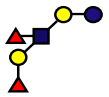
Table S2 Cell parameter (a_o) and pore wall thickness (W) of SBA-15 and SBA-15-C under different substrate proportions.

Parameter	Samples				
	SBA-15	SBA-15-C (1:1)	SBA-15-C (1:3)	SBA-15-C (1:5)	SBA-15-C (1:7)
a_o [a)] (nm)	10.99	10.36	10.36	10.17	10.26
W [b)] (nm)	3.25	3.87	4.87	5.35	5.39

[a)] a_o calculated on the basis of the SAXS patterns; [b)] W obtained by $W=a_0-d_{BJH}$.

Table S3

Table S3 The structural information of oligosaccharide isomers.

Isomers	Structural formula	Molecular weight (Da)	Structural diagram
LNFP-I	**Fucα1-2Glaβ1-3GlcNAcβ1-3Glaβ1-4Glc**	**853.31**	
LNFP-II	**(Fucα1-4)Glaβ1-3GlcNAcβ1-3Glaβ1-4Glc**	**853.31**	
LNnDFH-II	**Glaβ1-4(Fucα1-3)GlcNAcβ1-3Glaβ1-4(Fucα1-3)Glc**	**999.36**	
LNDFH-I	**Fucα1-2Galβ1-3(Fucα1-4)GlcNAcβ1-3Galβ1-4Glc**	**999.36**	

●) Glucose; ○) Galactose; ■) N-acetylglucosamine; ▲) Fucose