

Electronic supplementary information (ESI)

On preparing high abrasive resistance binderless and in situ N-doped granular activated carbon with NaOH/urea solution system

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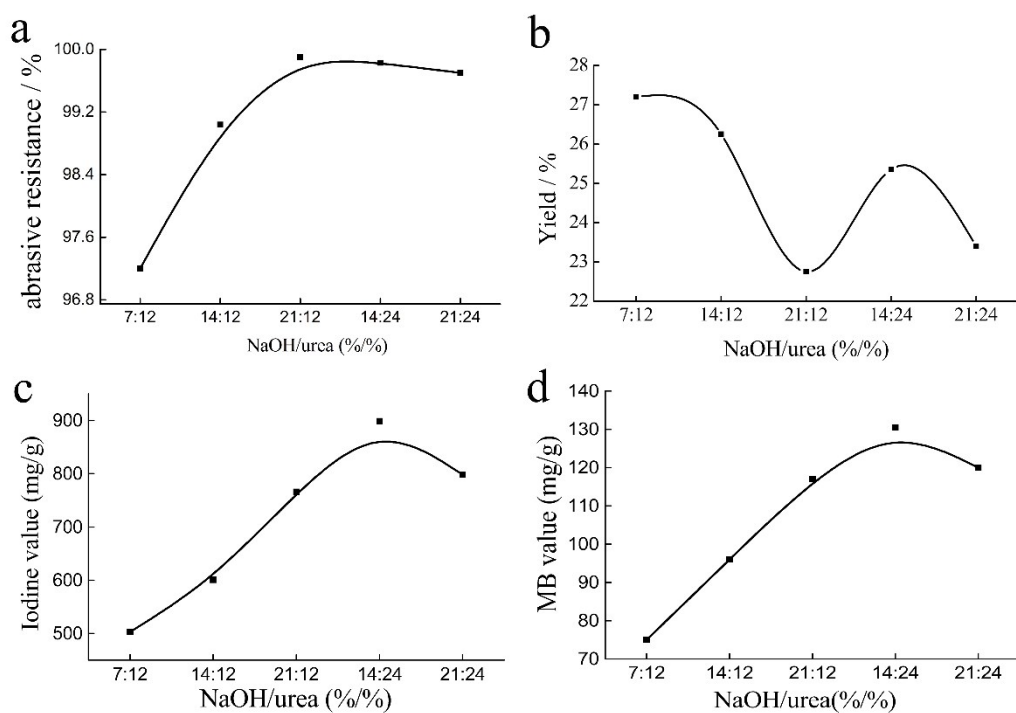


Fig. S1 Effects of NaOH/urea mass concentration ratio on abrasive resistance (a), yield (b) and adsorption performance (c, d) of NaOH/urea-GACs

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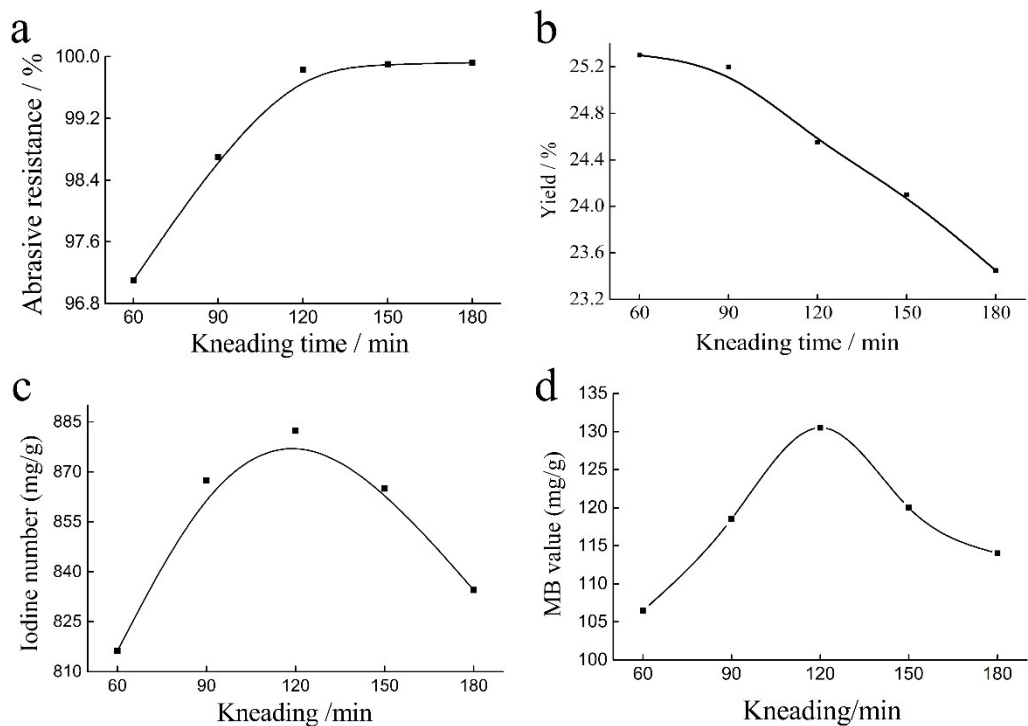


Fig. S2 Effects of kneading time on abrasive resistance (a), yield (b) and adsorption performance (b, d) of NaOH/urea-GACs

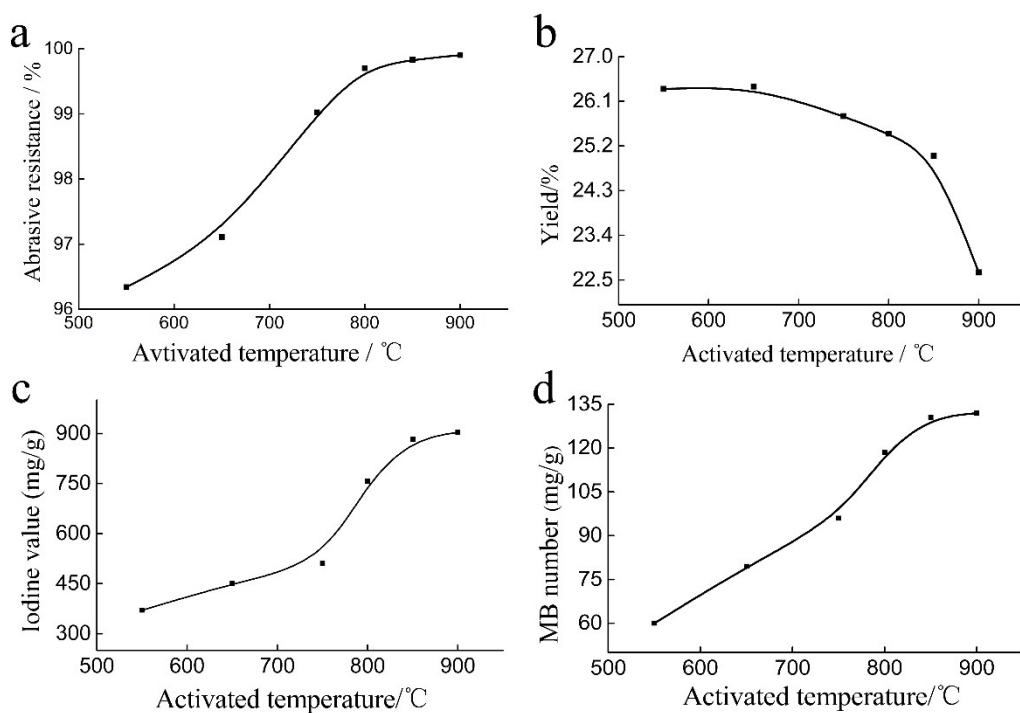


Fig. S3 Effects of activated time on abrasive resistance (a), yield (b) and adsorption performance (b, d) of NaOH/urea-GACs

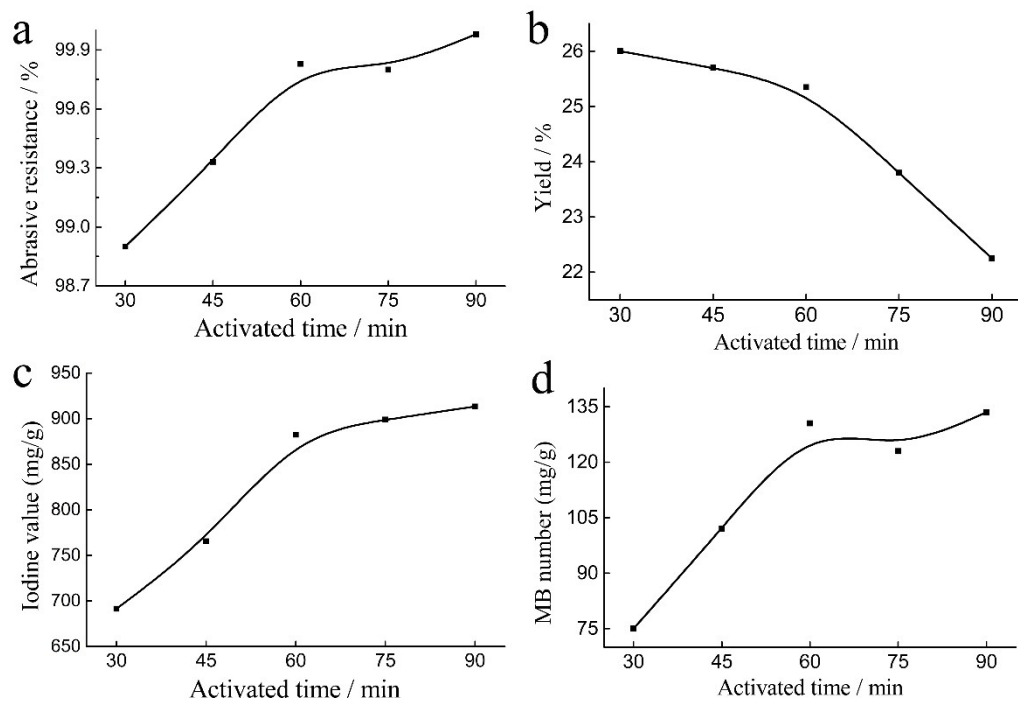


Fig. S4 Effects of activated temperature on abrasive resistance (a), yield (b) and adsorption performance (b, d) of NaOH/urea-GACs

Table S1 The factors and levels of RSA

factors	coding	levels		
		-1	0	1
Mass Concentration Ratio	X ₁	1 ^a	2 ^a	3 ^a
Activated Temperature/°C	X ₂	800	850	900
Activated Time/min	X ₃	50	70	90

a: 1, 2, 3 represent the alkali urea mass ratio of 14 : 12, 14 : 24 and 21: 24, respectively.

Table S2 The experimental designs and results of RSA

serial number	independent variable			Response value iodine value (mg·g ⁻¹)	
	X ₁	X ₂	X ₃	trial value	predicted value
1	1	0	1	887.03	886.10
2	-1	0	-1	789.75	790.68
3	1	-1	0	807.72	807.65
4	0	0	0	882.31	882.48
5	1	0	-1	812.41	812.76
6	0	1	-1	837.44	836.43
7	-1	0	1	827.85	827.50
8	1	1	0	868.33	868.99
9	-1	1	0	838.68	838.71
10	0	0	0	883.27	882.48
11	-1	-1	0	757.91	757.25
12	0	1	1	913.09	913.36
13	0	-1	-1	787.16	786.89
14	0	-1	1	819.11	820.12
15	0	0	0	881.98	882.48
16	0	0	0	882.10	882.48
17	0	0	0	882.76	882.48

Table S3 ANOVA for Response Surface Quadratic of Iodine value

Source	SS ^a	Df ^b	MS ^c	F-Value	P-Value
Model	31461.80	9	3495.76	3976.16	<0.0001
X ₁	3254.23	1	3254.23	3701.44	<0.0001
X ₂	10195.21	1	10195.21	11596.30	<0.0001
X ₃	6067.61	1	6067.61	6901.46	<0.0001
X ₁ X ₂	101.10	1	101.10	115.00	<0.0001
X ₁ X ₃	333.43	1	333.43	379.25	<0.0001
X ₂ X ₃	477.42	1	477.42	543.03	<0.0001
X ₁ ²	5807.37	1	5807.37	6605.45	<0.0001
X ₂ ²	3114.71	1	3114.71	3542.76	<0.0001
X ₃ ²	1089.48	1	1089.48	1239.20	<0.0001
Residual	6.15	7	0.88		
Lack of fit	5.03	3	1.68	5.96	0.0588
Pure error	1.13	4	0.28		
Cor total	31467.96	16			

a: Sum of square; b: Degree of freedom; c: Mean square.

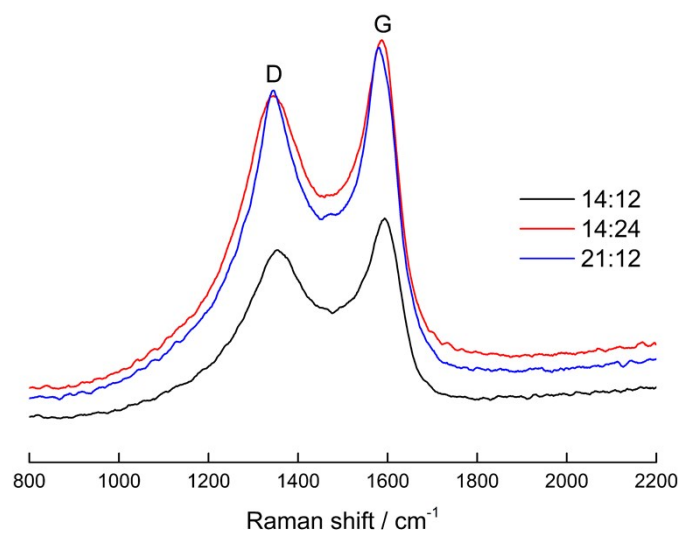


Fig. S5 Raman spectra of ordinary-GACs and NaOHurea GACs different ratio

Table S4 The analysis of R2 for regression equation of Iodine value

Standard deviation	Average value	Coefficient of variation/%	R ²	Adjusted R ²	Predicted R ²	Adequate precision
0.94	844.64	0.11	0.9998	0.9996	0.9974	217.080