

Supporting Information

Mesoporous activated biochar for As(III) adsorption: A new utilization approach for biogas residue

Dong Xia^{a,c}, Heng Li^{b*}, Zheng Chen^b, Peng Huang^d, Dun Fu^a, Qingbiao Li^a and Yuanpeng Wang^{a*}

^a Department of Chemical and Biochemical Engineering, College of Chemistry and Chemical Engineering, and The Key Laboratory for Synthetic Biotechnology of Xiamen City, Xiamen University, Xiamen 361005, P.R. China

^bKey laboratory of Estuarine Ecological Security and Environmental Health, Tan Kah Kee College, Xiamen University, Zhangzhou, P.R. China.

^c School of Chemistry, University of Leeds, Leeds, United Kingdom LS2 9 JT

^dSchool of Engineering and Physical Sciences, Heriot-Watt University, Edinburgh, EH 14 4AS, UK

Table S1. Specific surface area parameters of mesoporous activated biochars with different ZnCl₂ concentrations under different pyrolysis temperatures

Materials	S _{BET} (m ² /g)	S _{meso} (m ² /g)	S _{meso} /S _{BET} (%)
MB-1M-ZnCl ₂ -550 °C	396.0604	90.8610	22.94
MB-1M-ZnCl ₂ -600 °C	445.2706	103.0460	23.14
MB-1M-ZnCl ₂ -650 °C	459.0515	110.0640	23.97
MB-1M-ZnCl ₂ -700 °C	508.8322	118.0720	23.20
MB-1M-ZnCl ₂ -750 °C	533.9916	119.9490	22.46
MB-1M-ZnCl ₂ -800 °C	510.7610	145.5170	28.49
MB-2M-ZnCl ₂ -550 °C	753.8034	523.1240	69.40
MB-2M-ZnCl ₂ -600 °C	766.4887	560.3910	73.11
MB-2M-ZnCl ₂ -650 °C	624.3715	465.2070	74.51
MB-2M-ZnCl ₂ -700 °C	533.3004	382.6440	71.75
MB-2M-ZnCl ₂ -750 °C	613.6962	414.9160	67.61
MB-2M-ZnCl ₂ -800 °C	580.6878	410.8130	70.75
MB-2.5M-ZnCl ₂ -550 °C	591.4077	454.0060	76.77
MB-2.5M-ZnCl ₂ -600 °C (MB-ZnCl ₂ -600, in this work)	892.2990	701.6840	78.64
MB-2.5M-ZnCl ₂ -650 °C	794.3345	561.4570	70.68
MB-2.5M-ZnCl ₂ -700 °C	629.1086	474.3430	75.40
MB-2.5M-ZnCl ₂ -750 °C	722.1807	525.4820	72.76
MB-2.5M-ZnCl ₂ -800 °C	566.3716	410.9620	72.56
MB-3M-ZnCl ₂ -550 °C	263.0649	219.8940	83.59
MB-3M-ZnCl ₂ -600 °C	810.5384	613.3820	75.68
MB-3M-ZnCl ₂ -650 °C	735.6135	587.0570	79.81

MB-3M-ZnCl ₂ -700 °C	733.2649	548.3270	74.78
MB-3M-ZnCl ₂ -750 °C	629.7014	476.0320	75.60
MB-3M-ZnCl ₂ -800 °C	641.3082	491.6840	76.67

Table S2. Specific surface area parameters of activated biochars with and without different NaOH concentrations under different pyrolysis temperatures

Biochar name	S _{BET} (m ² /g)	S _{meso} (m ² /g)	S _{meso} /S _{BET} (%)
BC-550 °C	61.5843	17.4270	28.30
BC-600 °C	70.9620	25.5490	36.00
BC-650 °C	94.5014	38.8130	41.07
BC-700 °C	60.5986	41.1900	67.97
BC-750 °C	56.8637	47.1490	82.92
BC-800 °C	100.1258	50.9100	50.85
BC-1M-NaOH-550 °C	51.1572	24.6560	48.20
BC-1M-NaOH-600 °C	63.4493	43.6250	68.76
BC-1M-NaOH-650 °C	98.2143	48.6960	49.58
BC-1M-NaOH-700 °C	130.3110	73.2960	56.25
BC-1M-NaOH-750 °C	158.3940	130.2700	82.24
BC-1M-NaOH-800 °C	250.0906	139.3530	55.72
BC-2M-NaOH-550 °C	109.0836	67.1220	61.53
BC-2M-NaOH-600 °C	95.8025	67.3580	70.31
BC-2M-NaOH-650 °C	65.7011	56.0850	85.36
BC-2M-NaOH-700 °C	40.4481	17.8150	44.04
BC-2M-NaOH-750 °C	110.6528	78.9400	71.34
BC-2M-NaOH-800 °C	47.7480	40.3330	84.47
BC-2.5M-NaOH-550 °C	183.1158	95.8600	52.35
BC-2.5M-NaOH-600 °C (BC-NaOH-600, in this work)	115.8151	51.0910	44.11
BC-2.5M-NaOH-650 °C	95.9757	40.4570	42.15
BC-2.5M-NaOH-700 °C	86.8476	51.8850	59.74
BC-2.5M-NaOH-750 °C	182.8049	97.8900	53.55
BC-2.5M-NaOH-800 °C	195.1201	105.1810	53.91
BC-3M-NaOH-550 °C	90.5357	57.1570	63.13
BC-3M-NaOH-600 °C	139.6053	105.9480	75.89

BC-3M-NaOH-650 °C	72.9207	48.8280	66.97
BC-3M-NaOH-700 °C	84.5570	60.8830	72.00
BC-3M-NaOH-750 °C	153.0129	128.5150	83.99
BC-3M-NaOH-800 °C	126.7575	78.3810	61.84
BC-4M-NaOH-550 °C	46.6419	41.7280	89.46
BC-4M-NaOH-600 °C	112.1321	95.3670	85.05
BC-4M-NaOH-650 °C	88.7740	70.2200	79.10
BC-4M-NaOH-700 °C	65.3076	45.2270	69.25
BC-4M-NaOH-750 °C	64.8972	50.0480	77.12
BC-4M-NaOH-800 °C	23.5438	18.4610	78.41

Table S3. Elemental compositions analysis of biogas residue and MB-ZnCl₂-600

Physico-chemical properties	Biogas residue	MB-ZnCl ₂ -600
C (%)	24.47 ± 0.38	56.95 ± 0.38
H (%)	3.63 ± 0.02	1.30 ± 0.01
N (%)	1.24 ± 0.05	0.37 ± 0.22
S (%)	1.01 ± 0.05	0.66 ± 0.05
O (%)	69.61 ± 0.41	40.72 ± 0.11
Molar O/C	2.85 ± 0.06	0.71 ± 0.01
Yield (%)	-----	20.88
Ash (%)	-----	25.76

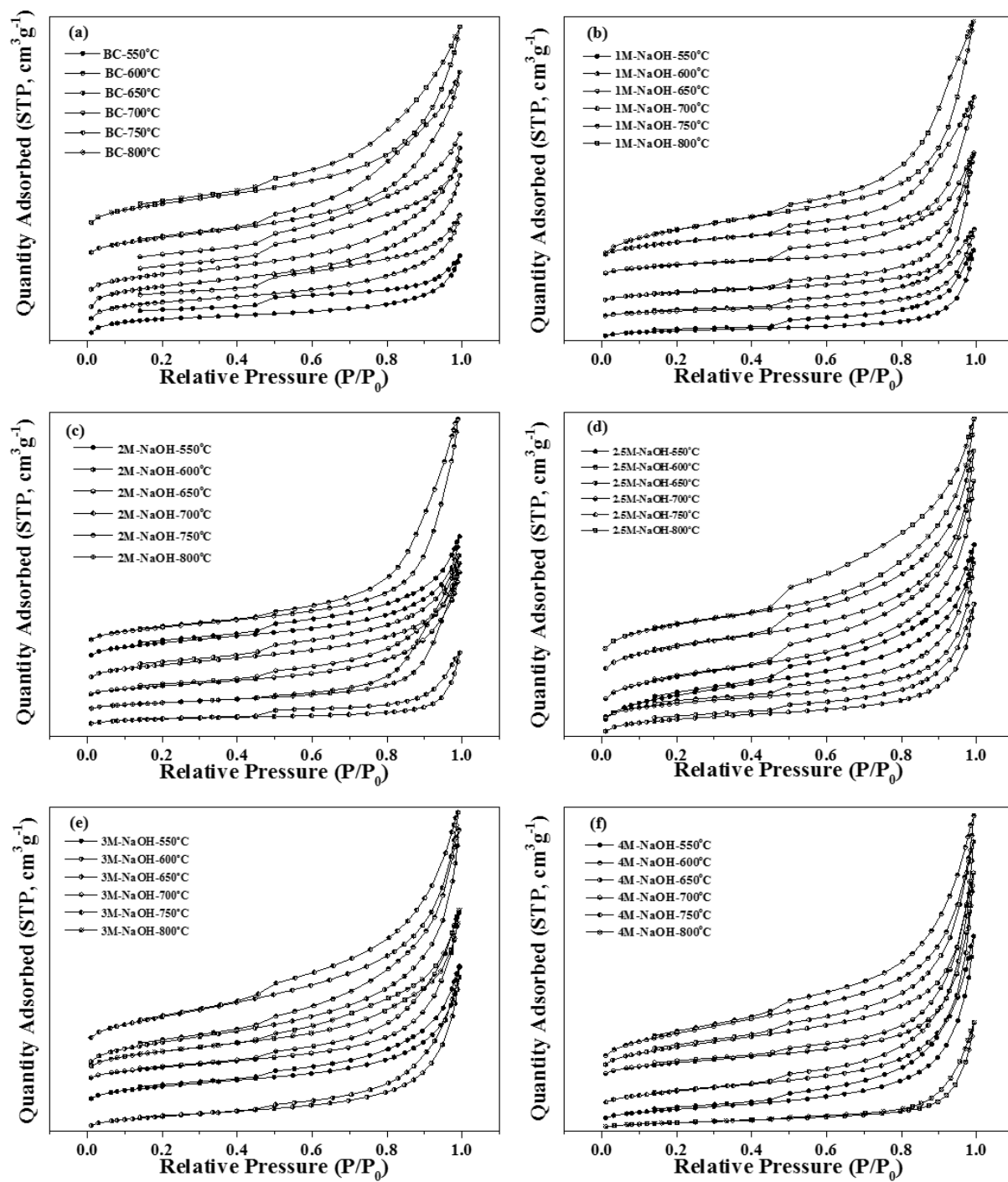


Figure S1. The nitrogen adsorption-desorption curves of (a) BC (b) 1M-NaOH (c) 2M-NaOH (d) 2.5M-NaOH (e) 3M-NaOH (f) 4M-NaOH activated biochars prepared at different temperature.

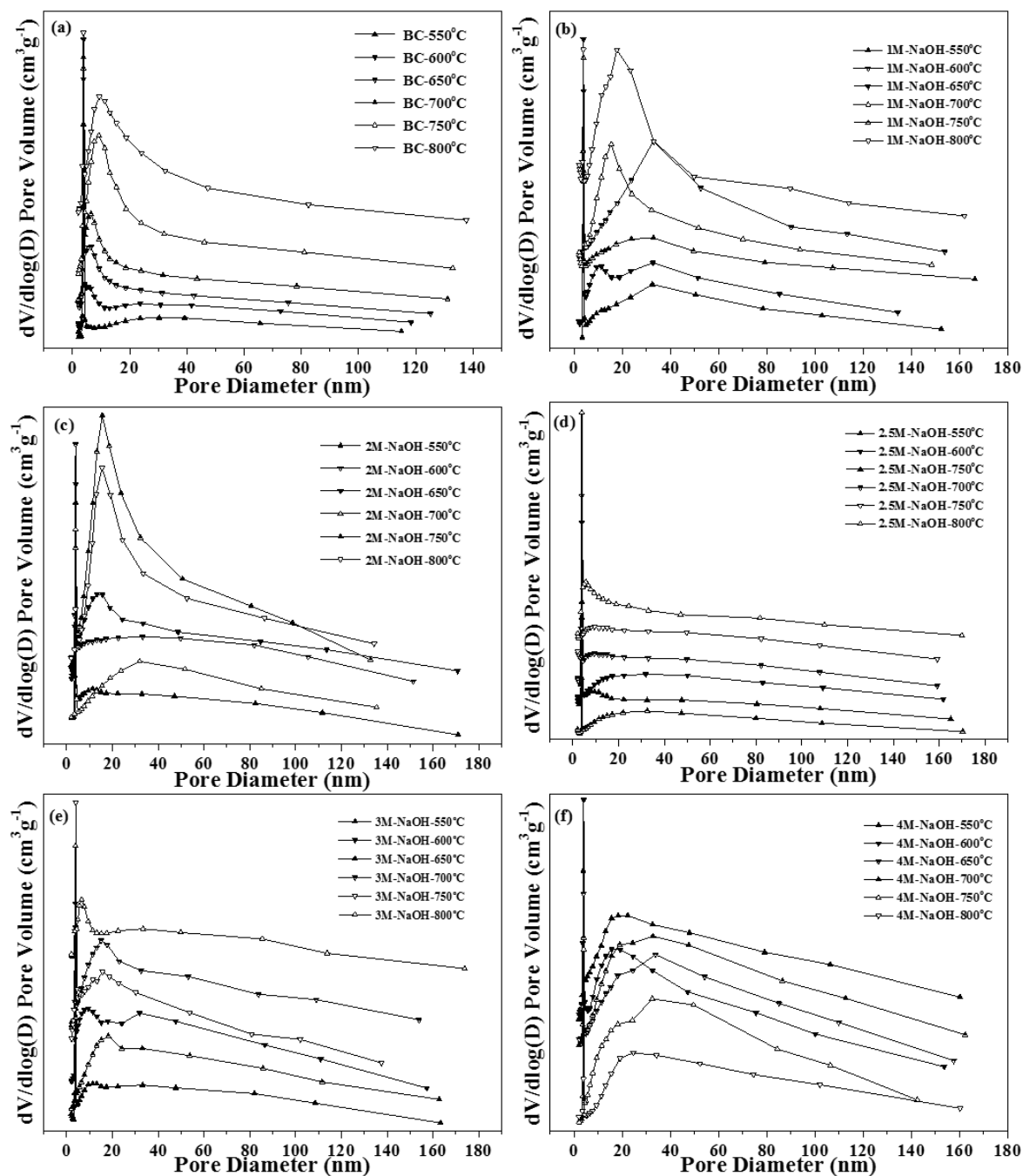


Figure S2. The BJH desorption pore size distribution of (a) BC (b) 1M-NaOH (c) 2M-NaOH (d) 2.5M-NaOH (e) 3M-NaOH (f) 4M-NaOH activated biochars prepared at different temperatures.

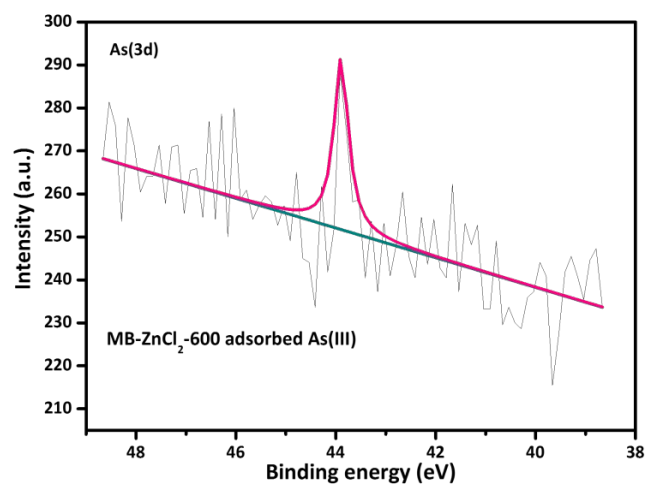


Figure S3. XPS spectra analysis of As(3d) in MB-ZnCl₂-600 after As(III) adsorption.