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University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

Al-based MOF derived self-assembled carbon nanosheets as innovative anodes for Li- and Na-ion batteries

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Keywords: Porous carbon nanosheets, nanostructure, 2D-MOF, Li-ion, Na-ion

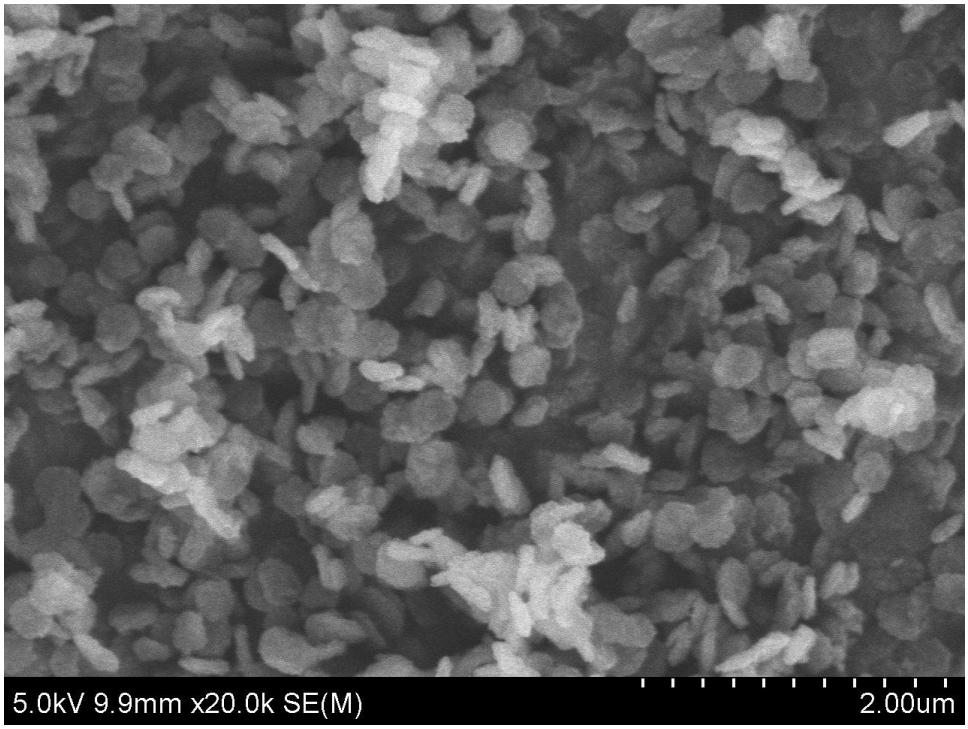


Figure.S1. FESEM images of the SAM.

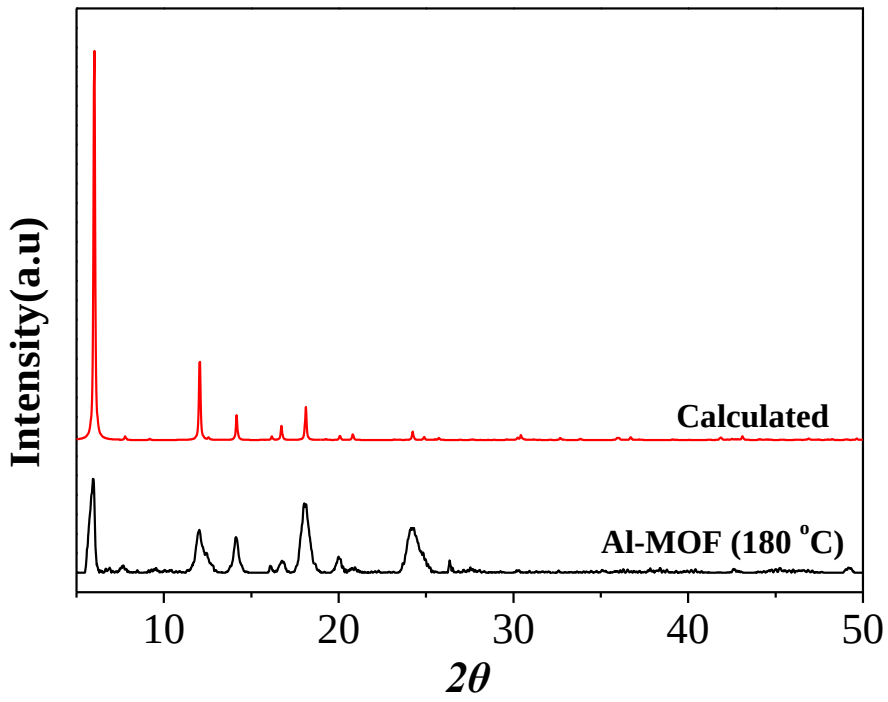


Figure.S2. Powder XRD patterns of the Al-MOF (180 ℃)

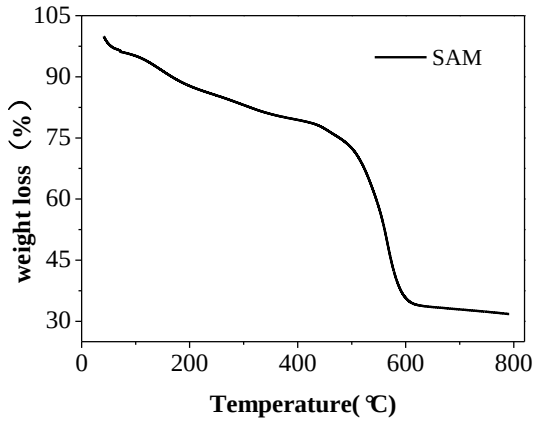


Figure.S3. TGA curves of the SAM.

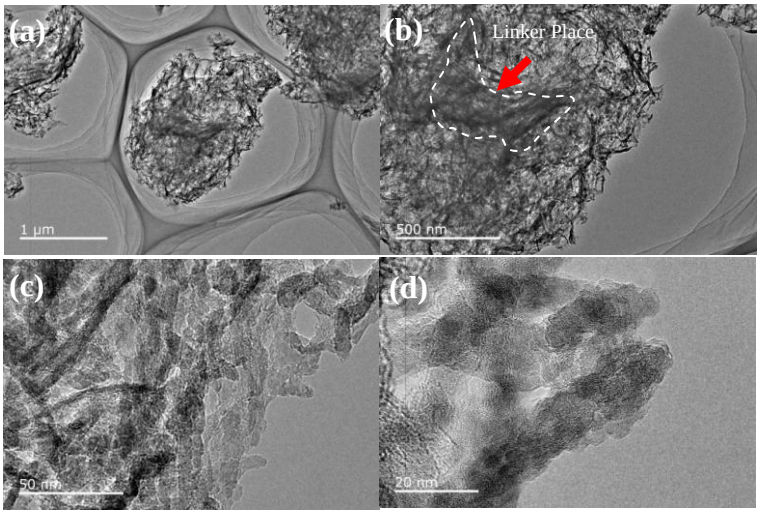


Figure.S4. (a,b) Low- and (c,d) high-magnification TEM images of the Al-MOF(180 ℃) derived carbon.

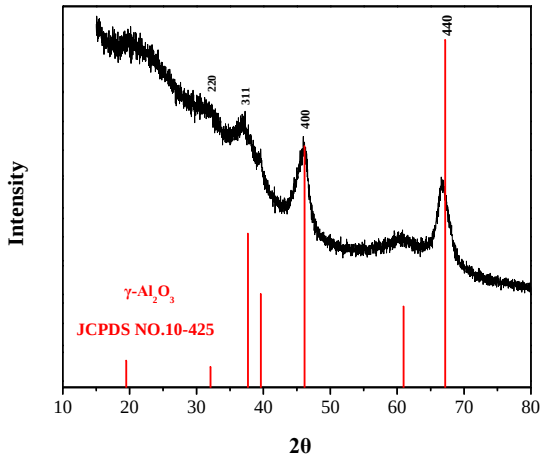


Figure.S5.XRD patterns from the Carbonization product of the SAM without hydrofluoric acid.

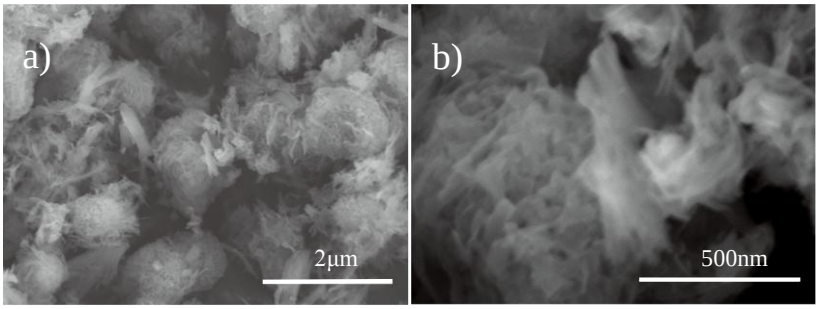


Figure.S6. FESEM images of the Al-MOF (180 ℃) derived Carbon (a,b).

Table.S1. Elemental Analysis Results for the carbonization product of the Al-MOF(180 ℃)

Carbonization product	N [wt%]	C [wt%]	H [wt%]	S [wt%]
Al-MOF (180° C)	0.32	58.2	3.006	0.573

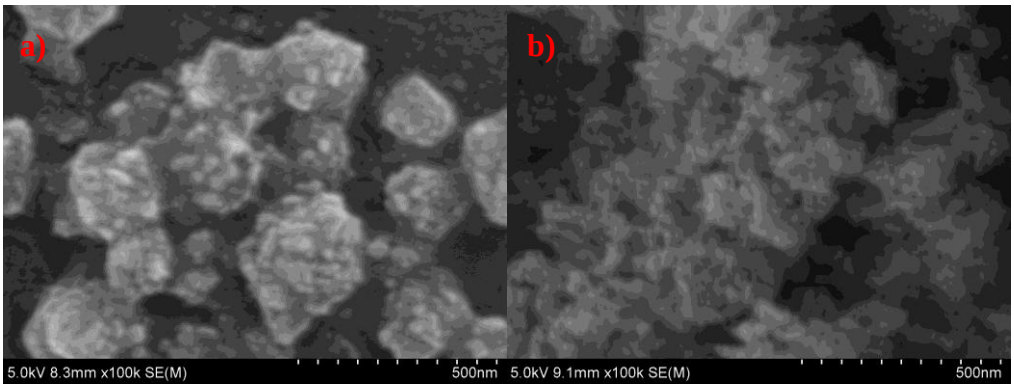


Fig. S7 FESEM images of the PCNS-700 after 100 cycles at 0.1C for LIBs (a) and 0.5C for NIBs (b).

Table S2. A survey of electrochemical properties of the carbon materials for LIBs

Category	SSA* ($m^2 g^{-1}$)	Template type	activation	Cycling stability	C-Rate performance
PCNS-700 (This work)	**1571.4 $m^2 g^{-1}$**	—	—	**825 mAh g^{-1}after 100 cycles at 0.1A g^{-1}**	**1126mA h.g^{-1},(0.1 A g)$^{-1}$** **748 mA h.g^{-1},(0.2 A g)$^{-1}$** **728 mA h.g^{-1},(0.5 A g)$^{-1}$** **702 mA h.g^{-1},(1 A g)$^{-1}$** **668 mA h.g^{-1},(2 A g)$^{-1}$** **489 mA h.g^{-1},(5 A g)$^{-1}$** **246 mA h.g^{-1},(10 A g)$^{-1}$** **244 mA h.g^{-1},(20 A g)$^{-1}$**
B-CN (Ref.[1])	480	NaCl	—	496 mA h.g^{-1} after 100 cycles at 0.1A g^{-1}	697 mA h.g^{-1},(0.1 A g)$^{-1}$ 575 mA h.g^{-1},(0.2 A g)$^{-1}$ 472 mA h.g^{-1},(0.3 A g)$^{-1}$ 406 mA h.g^{-1},(1 A g)$^{-1}$ 345 mA h.g^{-1},(2 A g)$^{-1}$ 285 mA h.g^{-1},(5 A g)$^{-1}$
NPCGS (Ref.[2])	781.3	GO	—	1040 mA h.g^{-1} after 200 cycles at 0.5 A g^{-1}	936 mA h g^{-1}, (0.1 A g)$^{-1}$ 854 mA h g^{-1}, (0.2 A g)$^{-1}$ 806 mA h g^{-1} , (0.4 A g)$^{-1}$ 728 mA h g^{-1} , (0.6 A g)$^{-1}$ 652 mA h g^{-1} , (0.8 A g)$^{-1}$ 606 mA h g^{-1}, (1 A g)$^{-1}$ 546 mA h g^{-1} , (2 A g)$^{-1}$ 459 mA h g^{-1}, (4 A g)$^{-1}$

NOSDCA-3 (Ref.[3])	852	—	KOH	839 mAh g^{-1} after 100 cycles at 0.1 A g^{-1} 390 mAh g^{-1} after 500 cycles at 1 A g^{-1}	484 mAh g^{-1} (1 A g^{-1}) 228 mAh g^{-1}(10 A g^{-1})
porous carbon spheres(Ref.[4])	559	—	—	507 mAh g^{-1} after 100 cycles at 0.1 A g^{-1}	400 mAh g^{-1} (0.2 A g^{-1}) 340 mAh g^{-1} (0.5 A g^{-1}) 305 mAh g^{-1} (1 A g^{-1}) 280 mAh g^{-1}(2A g^{-1}) 245mAh g^{-1}(5 A g^{-1}) 190mAh g^{-1}(10Ag $^{-1}$) 150 mAh g^{-1}(20Ag $^{-1}$)
mesoporous nanosheets (Ref.[5])	~281	AAO substrates	—	833 mAh g^{-1} after 60 cycles at 0.1 A g^{-1}	770 mAh g^{-1} (0.1 A g^{-1}) 540 mAh g^{-1} (0.2 A g^{-1}) 430 mAh g^{-1} (0.5 A g^{-1}) 370 mAh g^{-1} (1 A g^{-1}) 255 mAh g^{-1} (5 A g^{-1})
SRBCG (Ref.[6])	1431	MgO	—	510 mAh g^{-1} after 200cycles at 1 A g^{-1}	855 mAh g^{-1} (0.5 A g^{-1}) 472 mAh g^{-1} (1 A g^{-1}) 257 mAh g^{-1} (3.6 A g^{-1})
VFPC (Ref.[7])	2587	—	—	2016 mAh g^{-1} after 50cycles at 0.074A g^{-1}	245 mAh g^{-1} (5.55 A g^{-1})

***SSA (Specific surface area of MOF-derived carbon materials)**

Table S3. A survey of electrochemical properties of the carbon materials for SIBs

Category	SSA* (m^2 g^{-1})	Template type	activation	Cycling stability	C-Rate-performance
PCNS-700 (This work)	**1571.4**	**—**	**—**	**109.5 mAh g^{-1} after 3500 cycles at 1A g^{-1} 193 mAh g^{-1}after 100 cycles at 0.1A g^{-1}**	**841.49mA h.g^{-1},(0.02 A g)$^{-1}$ 287.13mA h.g^{-1},(0.04 A g)$^{-1}$ 257.46mA h.g^{-1},(0.1 A g)$^{-1}$ 244.82 mA h.g^{-1},(0.2 A g)$^{-1}$ 233.62 mA h.g^{-1},(0.4 A g)$^{-1}$ 221.79 mA h.g^{-1},(1 A g)$^{-1}$ 212.92 mA h.g^{-1},(2 A g)$^{-1}$ 198.83 mA h.g^{-1},(4 A g)$^{-1}$ 179.77 mA h.g^{-1},(10 A g)$^{-1}$ 161.79 mA h.g^{-1},(20 A g)$^{-1}$**

MOF5DC (Ref.[8])	1205	—	—	89.04 mAh g^{-1} after 66 cycles at 0.4A g^{-1}	152.00mA h.g^{-1},(0.05 A g)$^{-1}$ 128.36mA h.g^{-1},(0.1 A g)$^{-1}$ 106.59mA h.g^{-1},(0.15 A g)$^{-1}$ 92.69mA h.g^{-1},(0.2 A g)$^{-1}$
B-CN (Ref.[1])	480	NaCl	—	195.1 mAh g^{-1}after 100 cycles at 0.1A g^{-1}	276mAh g -1 at 0.2 A g -1 260mAh g -1 at 0.5 A g -1 228mAh g -1 at 1 A g -1 209 mAh g -1 at 2 A g -1 189 mAh g -1 at 5 A g -1
BPC (Ref.[9])	763.3	—	KOH	229 mAh g^{-1} at 200 cycles and 0.2A g^{-1}	224 mAh g -1 at 0.05 A g -1 242 mAh g -1 at 0.1 A g -1 238 mAh g -1 at 0.2 A g -1 207 mAh g -1 at 0.5 A g -1 158 mAh g -1 at 1 A g -1 102 mAh g -1 at 2 A g -1 68 mAh g -1 at 5 A g -1 43 mAh g -1 at 10 A g -1
ACFs-5 (Ref.[10])	1508.0	—	KOH	243 mAh g^{-1} at 100 cycles and 0.05 A g^{-1}	153 mAh g -1 at 1 A g -1 134 mAh g -1 at 2 A g -1 101 mAh g -1 at 5 A g -1 72 mAh g -1 at 10 A g -1
G-NCs (Ref.[11])	133.8	Graphene oxide	—	154 mAh g^{-1} at 10000 cycles and 5A g^{-1}	250 mAh g -1 at 100 mA g -1 110 mAh g -1 at 10000 mA g -1
PGGs (Ref.[12])	1598	Ag nanoparticles	—	112 mAh g^{-1} after 1000 cycles and 1A g^{-1}	210.2 mAh g -1 at 0.028A g -1 160.2 mAh g -1 at 0.057 A g -1 112.2 mAh g -1 at 0.140A g -1
3DHSC-4 (Ref.[13])	119	NaCl	—	200.7 mAh g^{-1} at 120 cycles and 0.05 A g^{-1}	97mAh g -1 at 5A g -1
CNCs (Ref.[14])	~190	ZnO nanocrystals	—	212 mAh g^{-1} after 1000cycles at 1.5 A g^{-1}	385 mAh g -1 at 0.05 A g -1 325 mAh g -1 at 0.1 A g -1 307 mAh g -1 at 0.2 A g -1 286 mAh g -1 at 0.4 A g -1 275 mAh g -1 at 0.8A g -1 262 mAh g -1 at 1.6 A g -1 252 mAh g -1 at 3.2 A g -1
NSCN (Ref.[15])	674	$Mg(OH)_2$	—	248 mAh g^{-1} after 500cycles at 0.1A g^{-1}	176 mAh g^{-1} (2 A g^{-1})
NPC-CNT@G (Ref.[16])	529.6	CNT	—	257 mAh g^{-1} after 100cycles at 0.1A g^{-1} 163 mAh g^{-1} after	315 mAh g -1 at 0.05A g -1 284mAh g -1 at 0.1 A g -1 249 mAh g -1 at 0.2 A g -1

	300cycles at 1A g^{-1}	208mAh g^{-1} at 0.5 A g^{-1} 174mAh g^{-1} at 1 A g^{-1} 146 mAh g^{-1} at 2 A g^{-1}

***SSA (Specific surface area of MOF-derived carbon materials)**

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