

Electronic Supplementary Information (ESI) for

Enhancement of the rate performance of plasma-treated platelet carbon nanofiber anode in lithium-ion battery

Yu-Jin Han,^a Choonghyeon Lee,^b Young Deok Seo,^b Koji Nakabayashi,^c Jin Miyawaki,^c

Ricardo Santamaría,^d Rosa Menéndez,^d Jyongsik Jang^{*,b} and Seong-Ho Yoon^{*,a,c}

a) Interdisciplinary Graduated School of Engineering Sciences, Kyushu University, Fukuoka, Japan. E-mail: yoon@cm.kyushu-u.ac.jp, Tel.: +81-92-583-7959, Fax: +81-92-583-7879

b) School of Chemical and Biological Engineering, College of Engineering, Seoul National University, Seoul, Korea. E-mail: jsjang@plaza.snu.ac.kr, Tel.: +82-2-880-7069, Fax: +82-2-888-1604

c) Institute for Materials Chemistry and Engineering, Kyushu University, Fukuoka, Japan

d) Department of Chemistry of Materials, Instituto Nacional del Carbón, INCAR-CSIC, Oviedo, Spain

Supporting Figures

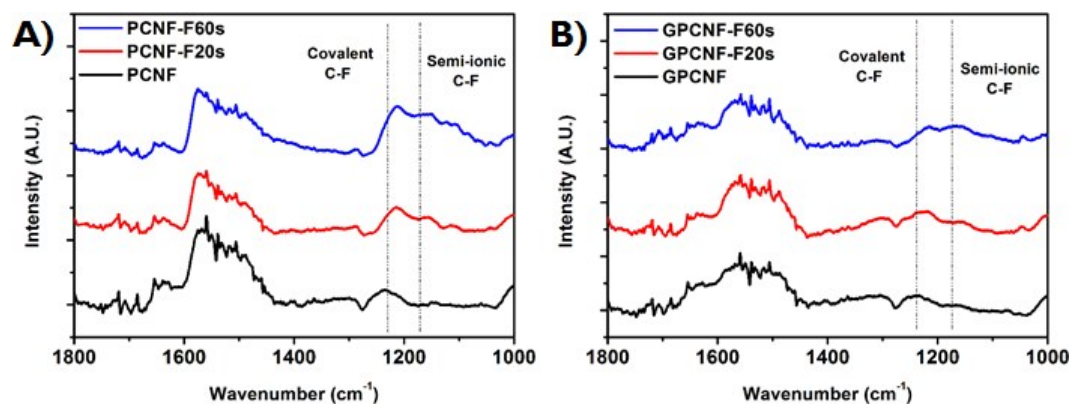


Fig. S1 FT-IR spectra of a) PCNF, PCNF-F20s, PCNF-F60s and b) GPCNF, GPCNF-F20s, GPCNF-F60s.

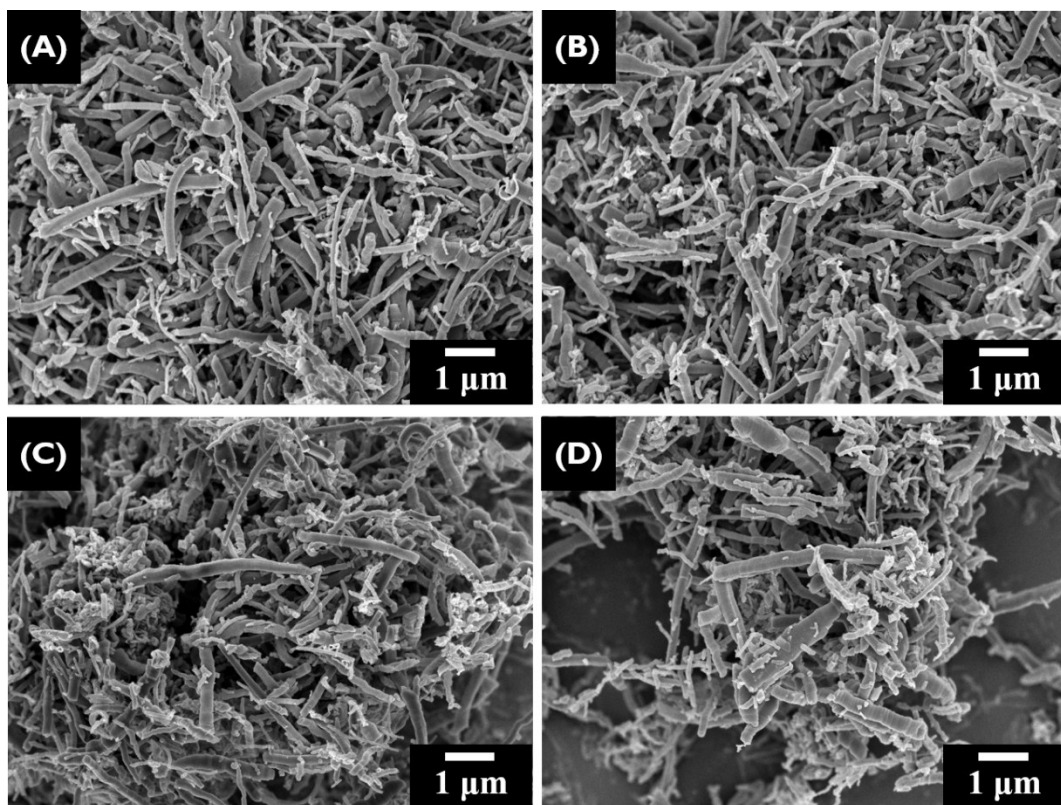


Fig. S2 SEM images of a) PCNF; b) PCNF-F60s; c) GPCNF and d) GPCNF-F60s. All images were taken at X10000 magnification.

Table S1 Elemental compositions of the C_mF_n- modified PCNFs/GPCNFs.

Samples	Elemental analysis (%)			XPS (%)		
	C	O_{diff.}	& F_{diff.}	C	O	F
PCNF	99.5		0.5	91.5	8.5	-
PCNF-F5s	98.7		1.3	89.0	7.6	3.4
PCNF-F20s	98.2		1.8	89.9	6.0	4.1
PCNF-F60s	98.0		2.0	90.7	3.7	5.6
GPCNF	99.9		0.1	93.8	6.2	-
GPCNF-F5s	99.4		0.6	90.9	7.5	1.6
GPCNF-F20s	98.5		1.5	89.6	7.2	3.2
GPCNF-F60s	98.2		1.8	89.4	6.8	3.8

Table S2 XPS F1s analysis results of the C_mF_n-modified PCNFs/GPCNFs.

Samples	Ionic (684.6 ± 0.5 eV)	Semi-ionic (687.1 ± 0.5 eV)	Covalent (690.0 ± 0.5 eV)
PCNF-F5s	27	73	-
PCNF-F20s	-	100	-
PCNF-F60s	4	87	9
GPCNF-F5s	18	82	-
GPCNF-F20s	32	68	-
GPCNF-F60s	23	59	18

Table S3 TOF-SIMS analysis results of the C_mF_n-modified PCNFs/GPCNFs.

Sample	Normalized peak intensity ratios				
	CF ₂ ⁺ /C ⁺	CF ₃ ⁺ /C ⁺	C ₂ F ₃ ⁺ /C ⁺	C ₃ F ₃ ⁺ /C ⁺	C ₃ F ₅ ⁺ /C ⁺
PCNF-F5s	0.62	0.48	0.51	0.31	0.26
PCNF-F20s	0.73	0.73	0.59	0.43	0.38
PCNF-F60s	0.96	1.72	1.55	0.83	0.79
GPCNF-F5s	1.36	1.16	1.21	0.64	0.50
GPCNF-F20s	1.23	1.41	1.30	0.75	0.55
GPCNF-F60s	1.45	2.97	2.98	1.14	0.96

Table S4 XRD, Raman and BET analysis results of the C_mF_n-modified PCNFs/GPCNFs.

Samples	Crystallographic parameters		Raman spectra	BET
	d ₀₀₂ (Å)	Lc ₀₀₂ (nm)	R (I _D /I _G)	Surface area (m ² /g)
PCNF	3.367	56	1.68	97
PCNF-F5s	3.357	61	1.57	95
PCNF-F20s	3.360	62	1.55	93
PCNF-F60s	3.364	68	1.45	90
GPCNF	3.368	72	0.25	60
GPCNF-F5s	3.365	73	0.24	59
GPCNF-F20s	3.362	<100	0.26	58
GPCNF-F60s	3.360	<100	0.25	56

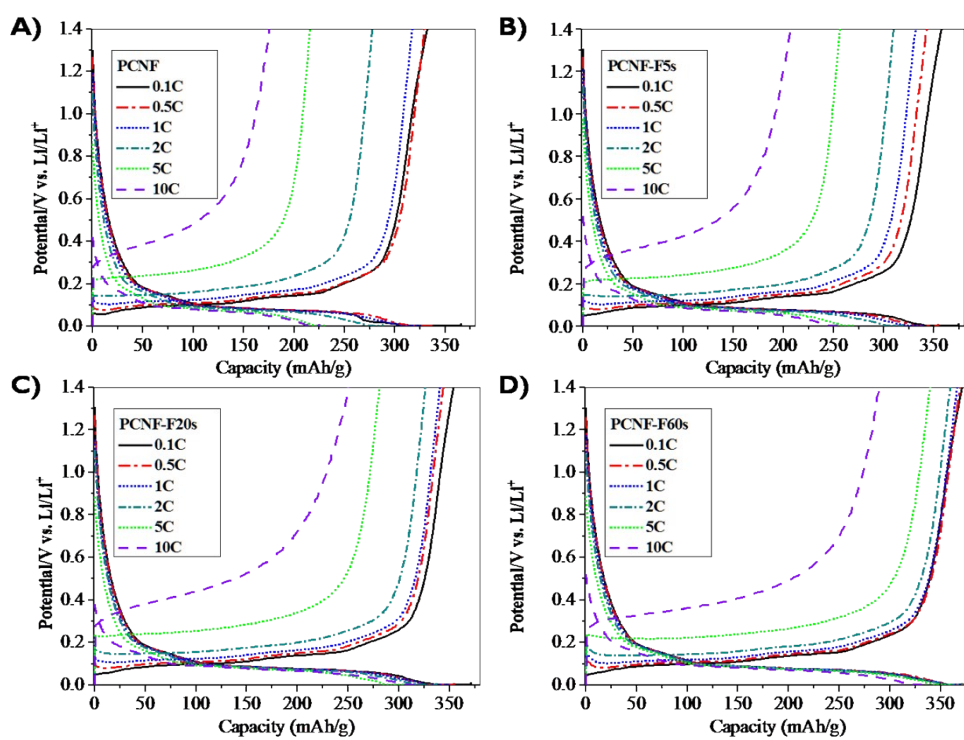


Fig. S3 Charge/discharge profiles of PCNF and C_mF_n -modified PCNFs at various current rates ranging from 0.1C to 10C (1C = 372 mAh/g)

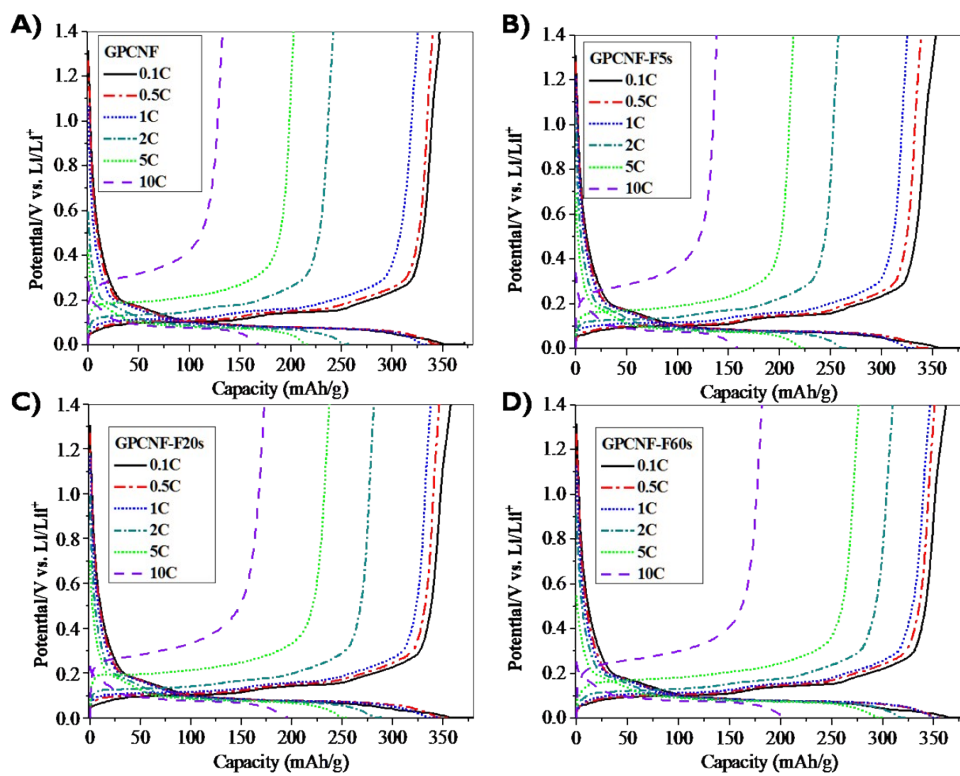


Fig. S4 Charge/discharge profiles of GPCNF and C_mF_n -modified GPCNFs at various current rates ranging from 0.1C to 10C (1C = 372 mAh/g)

Table S5 Coulombic efficiency of the pristine PCNF/GPCNF and C_mF_n-modified PCNFs/GPCNFs per C-rate after 5 cycles.

Sample	Coulombic efficiency per C-rate after 5 cycles (%)					
	0.1C	0.5C	1C	2C	5C	10C
PCNF	94.1	97.7	97.9	97.2	93.5	81.0
PCNF-F5s	96.7	96.8	98.2	98.0	94.3	82.4
PCNF-F20s	96.6	97.8	98.0	97.8	93.9	84.3
PCNF-F60s	96.5	97.5	97.9	97.5	94.8	88.2
GPCNF	94.3	98.3	97.3	94.8	93.5	82.1
GPCNF-F5s	94.2	98.4	98.5	97.6	95.7	84.0
GPCNF-F20s	95.2	98.2	98.6	98.1	94.4	83.8
GPCNF-F60s	95.2	98.2	98.0	96.4	92.9	86.2

Table S6 R_{ct} value of pristine PCNF/GPCNF and C_mF_n -modified PCNFs/GPCNFs

	Resistance	
	Passivation (R_f, Ω)	Charge transfer (R_{ct}, Ω)
PCNF	12.4	12.3
PCNF-F5s	5.2	10.7
PCNF-F20s	4.8	8.4
PCNF-F60s	3.9	6.7
GPCNF	6.9	9.0
GPCNF-F5s	5.7	5.8
GPCNF-F20s	4.6	5.6
GPCNF-F60s	3.4	4.5