Supplementary Information

In-situ fabrication of graphene/carbon nanochain webs as anodes for Li-ion batteries

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Experimental Section

Graphite oxide was first synthesized by a modified Hummers' method[S1]. 120 mg graphite oxide was dispersed into 100 mL pure water by ultrasonication for 2h, and transferred to an airtight reactor for 2 h at 160 ℃. Then, 10 mL HCl and cetrimonium bromide (CTAB, 7.3 g) were dissolved in the above-mentioned solution under ice bath. After that, 1 mL pyrrole monomer and ammonium persulfate (APS, 6.8 g) were added under magnetic stirring. The polymerization reaction was carried out for 5 h at 0 ℃. Finally, a black precipitate was collected, washed with distilled water and dried under vacuum at 0 ℃ for 2 days, followed by heating in a tube furnace under high-purity Ar at 805 ℃ for 2 h at a heating rate of 3 ℃·min^{-1}. The as-prepared sample was designated as GCNW. For comparison, the pure carbon nanochain webs (CNW) were synthesized without the graphene added.

Scanning electron microscopy (SEM, JSM-6360LV, Japan), transmission electron microscopy (TEM, JEM-2100F, Japan), atomic force microscopy (AFM, NanoScope (R) III) were taken to characterize the composite. Laser raman spectroscopy (OLYMPUS, BX41) was used to observe the type of carbon materials.

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Electrochemical performances were performed with 2025 coin cells using Li foil as counter electrode. The working electrode was prepared by mixing 80% composite, 10% carbon black, and 10% polyvinylidene fluoride into N-methylpyrrolidinone. The slurry was pasted onto copper foil and dried overnight at 120℃ in vacuum. The electrolyte was 1molL^{-1} $LiPF_6$ dissolved in a mixture of ethylene carbonate/diethyl carbonate (1:1, by volume). The cells were assembled in an argon-filled glove box (1220/750, Shanghai). Galvanostatic discharge/charge experiments were performed using battery testers (CT-2001A, Wuhan). Electrochemical workstation (1470E, USA) was taken to measure the cyclic voltammograms. In this paper. The galvanostatic discharge/charge and cyclic voltammograms (CV) experiments were taken at a scanning rate of 0.2 mVs^{-1} in the potential range of 0.01-3.0 V.

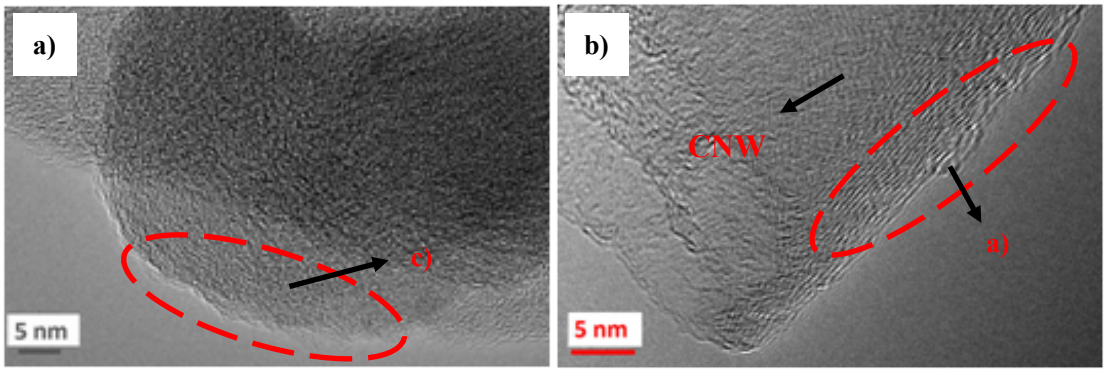

Figure S1. HETEM images of CNW, d) HETEM image of GCNW.

From Figure.S1, it could be clearly found the1D carbon nanochain was coated by graphene for the GCNW, compared with CNW.

Table S1 Elemental composition of GCNW and CNW.

Sample	Sample Chemical composition [atom%]		
	C1s	N 1s	O 1s
GCNW	78.69	12.08	9.23
CNW	89.53	5.11	5.36

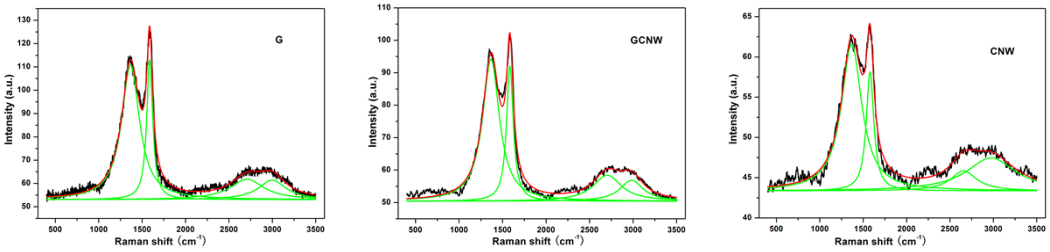

Fig. S2 Curve fits for Raman spectra of the G, GCNW and CNW.

Table. S2 Raman parameters of G,GCNW and CNW

Sample	D-band		G-band		2D-band		(D+G)-band	
	Raman shift	FWHM	Raman shift	FWHM	Raman shift	FWHM	Raman shift	FWHM
G	1366.9	249.5	1587.2	83.5	2708.6	474.1	2998.55	382.76
GCNW	1367.6	235.2	1584.7	93.2	2703.7	394.8	2981.5	321.7
CNW	1366.91	284.27	1579.1	104.5	2658.28	359.4	2972.8	685.1

S1. L. Noerochim, J.Z. Wang, S.L. Chou, D. Wexler and H.K. Liu, *Carbon*, 2012, **50**, 1289.

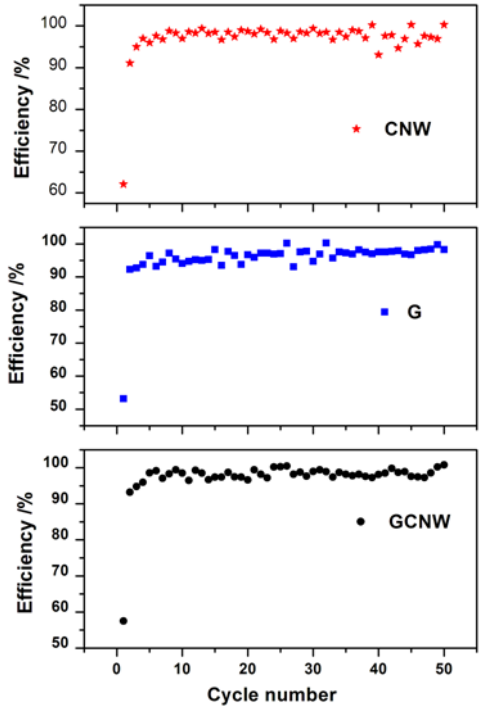

Fig.S3 Capacity efficiency of a) GCNW, b) G and c) CNW.

In Figure.S3, the capacity efficiency of GCNW is lower than that of CNW, but higher than that of G. After the first cycle, the coulombic efficiency of the three electrodes are above 95%, indicating the irreversible capacity loss decrease significantly. Compared with G, GCNW and CNW show the higher capacity retention. It is mainly attributed to the structural defects of G that lead to irreversible lithium insertion.

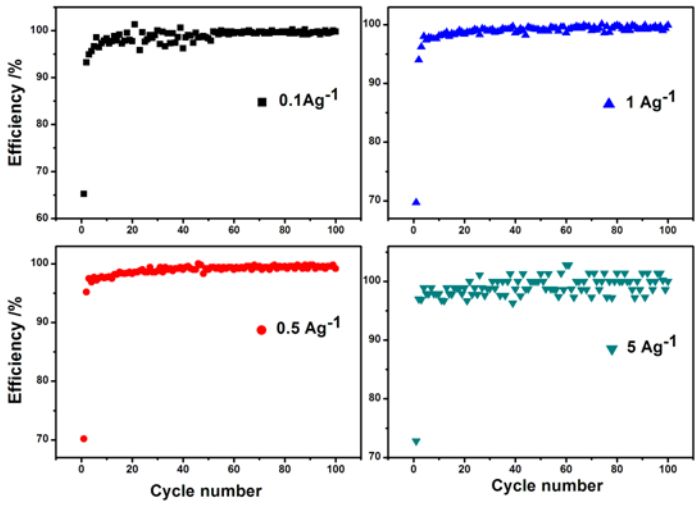

Fig.S4 Capacity efficiency of GCNW at a) 0.1, b) 0.5, c) 1 and d) 5 Ag^{-1}

In Figure.S4, the coulombic efficiency of GCNW in the first cycle increases with the increase of the current density. It is due to some side reactions did not occur at fast ion transportation and the incomplete decomposition of the electrolyte during the formation of SEI film. After the first cycle, the GCNW electrode demonstrates highly reversible behavior at each current density indicating the super cycleability and rate ability of the GCNW electrode.