Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supplementary Information

Additive-Free Synthesis of $Li_4Ti_5O_{12}$ Nanowire Arrays on Freestanding Ultrathin Graphite as a Hybrid Anode for Flexible Lithium Ion Battery

*Seong Dae Kim,‡[a] Kuldeep Rana,‡[a,b], Jong-Hyun Ahn[*a]*

[a]. *School of Electrical and Electronic engineering, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul 03722, Republic of Korea*
[b].*Current address: Electrical Appliance and Technology Division, Central Power Research Institute, Prof. Sir CV Raman Road, Bangalore, Karnataka, 560080, India.*

‡ S. D. Kim and K. Rana contributed equally to this work

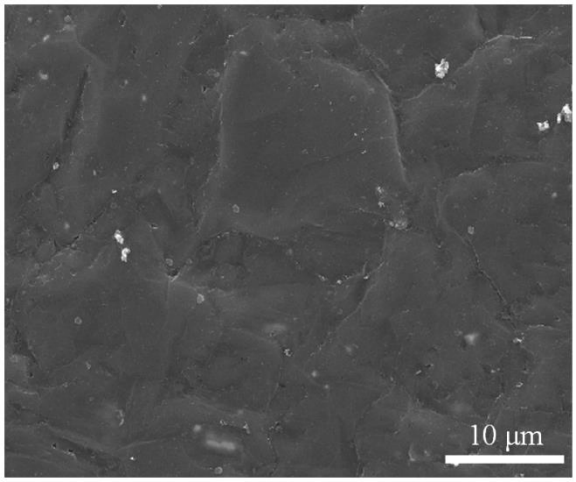

Figure S1. SEM observation of the surface of FSG.

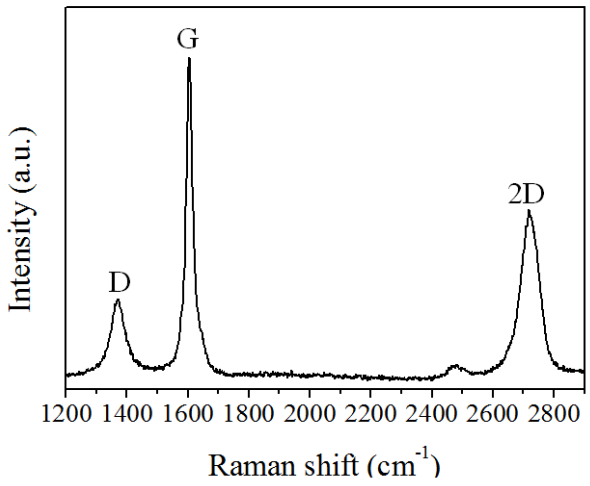

Figure S2. Raman spectrum of FSG.

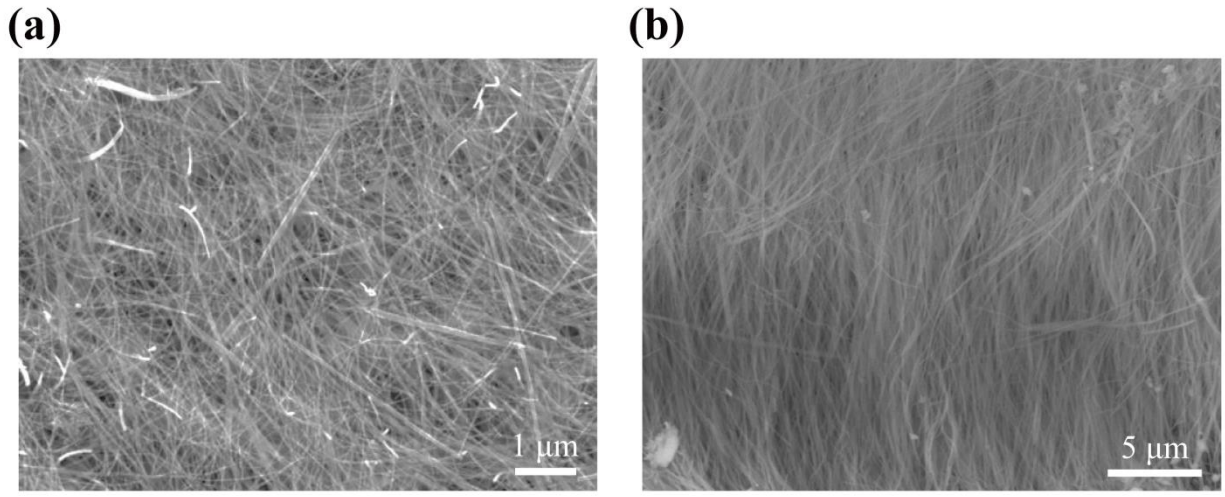

Figure S3. SEM observation of LTO-Ti (a) Top view. (b) side view.

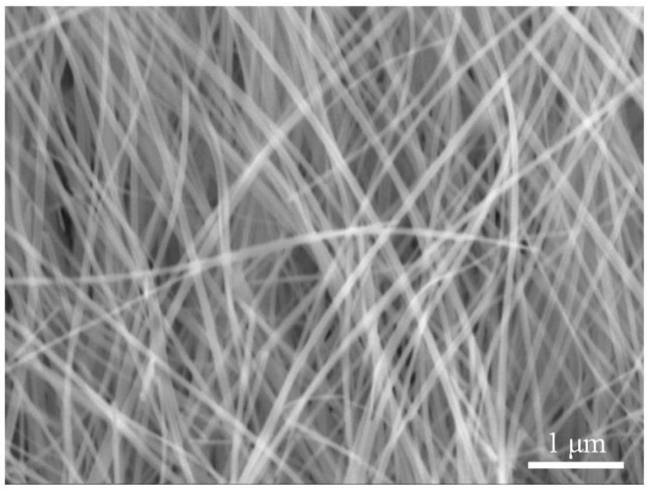

Figure S4. SEM images of $Na_2Ti_2O_5 \cdot H_2O$ NW array on FSG right after hydrothermal process.

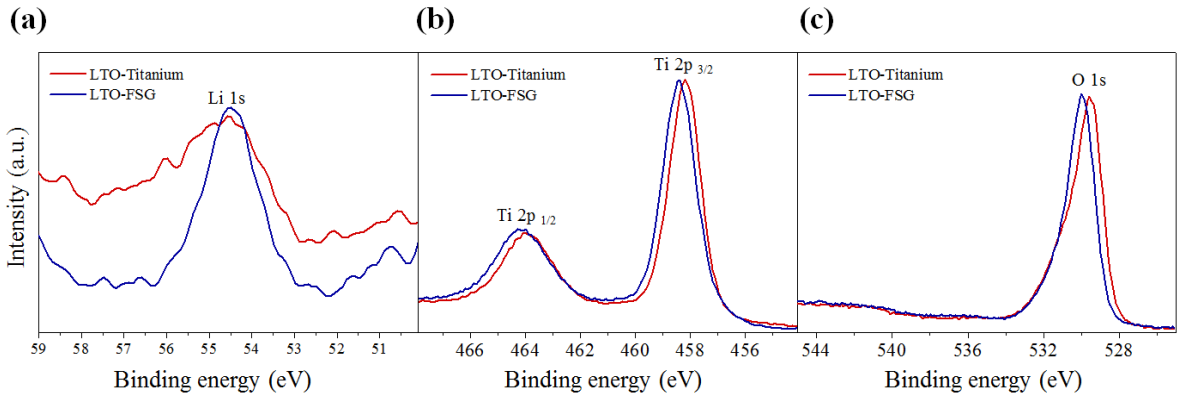

Figure S5. XPS spectra of LTO NW on both Ti and FSG with focusing on a) lithium, b) titanium, and c) oxygen.

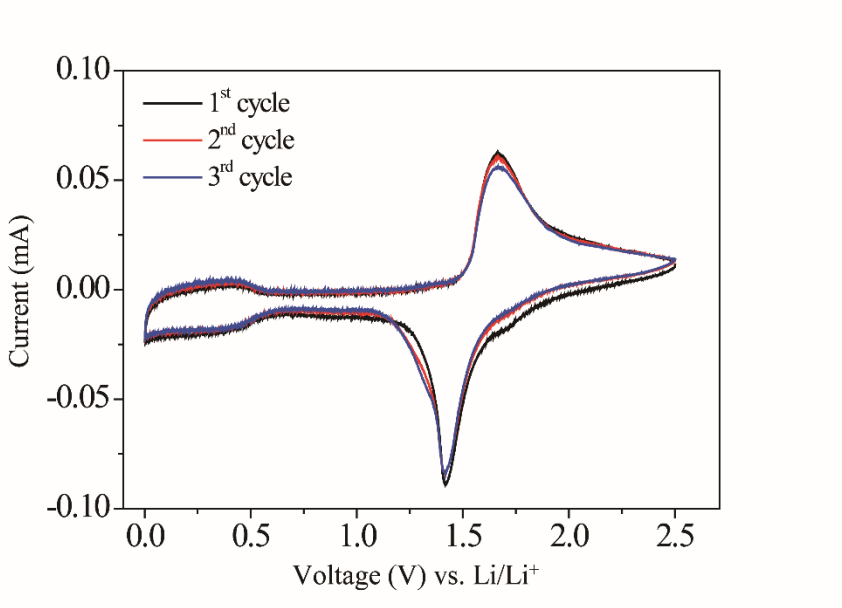

Figure S6. Cyclic voltammogram of LTO-Ti with the range of 0-2.5 V vs. Li/Li^+.

Table S1. High power capability comparison of LTO-based anodes.

Materials	Nano structure	Direct synthesis	Current collector	C-Rate	Capacity retention	Reference
LTO-FSG	Nanowire	O	FSG	1 C	92 %	**This work**
				30 C	59 %	
				60 C	47 %	
LTO	Nanowire	O	Titanium	1 C	97 %	L. Shen[38]
				30 C	69 %	
LTO/ RGO	Nano-particle	X	Copper	1 C	99 %	Q. Zhang[59]
				20 C	64 %	
LTO/ graphene nanosheet	Nano-particle	X	Copper	1 C	91%	B. Zhang[60]
				4 C	58 %	
LTO / C	Nano-composite	X	Copper	1C	79 %	W. Fang[61]
				20 C	34 %	
LTO	Hierarchical hollow LTO Unchin-like microsphere	X	Copper	1 C	98 %	J. Cheng[62]
				20 C	69 %	
LTO/ TIO_2/ Carbon	Mesoporous microsphere with nanostructure	X	Copper	1 C	96 %	L. Gao[63]
				5 C	70 %	
LTO/ graphene	LTO nanoparticle on graphene	X	Copper	1 C	93 %	L. Shen[64]
				60 C	47 %	
LTO	Donut-shape with nano grain	X	Copper	1 C	73 %	A. K. Haridas[65]
				10 C	38 %	

Table S2. Comparison of several researches of binder-free synthesis electrode with focusing on inactive materials with lithium ion which do not make any capacity.

Materials	**structure**	**Direct synthesis**	**Inactive materials**	**Flexibility**	**Reference**
LTO-FSG	LTO nanowire on FSG	O	X	◎	**Our work**
LTO	LTO nanowire on titanium foil	O	Titanium	△	L. Shen[38]
LTO	LTO nanosheet on titanium foil	O	Titanium	O	S. Chen[55]
LTO-C	LTO-C nanotube on stainless steel	O	Stainless steel(iron)	△	J. Liu[67]
LTO	LTO slurry on CNT/PVDF-coated paper	X	Additive, PVDF	◎	Q. Cheng[68]
Si	Silicon nanotube on stainless steel	O	Stainless steel(iron)	X	T. Song[34]
Si	Silicon nanowire on stainless steel	O	Stainless steel(iron)	X	C. K. Chan[69]
$ZnCo_2O_4$	$ZnCo_2O_4$ nanowire on carbon cloth	O	Carbon cloth (low property)	O	B. Liu[24]