

## Supporting Information

### A Multifunctional Artificial Protective Layer Producing an Ultra-stable Lithium Metal Anode in a Commercial Carbonate Electrolyte

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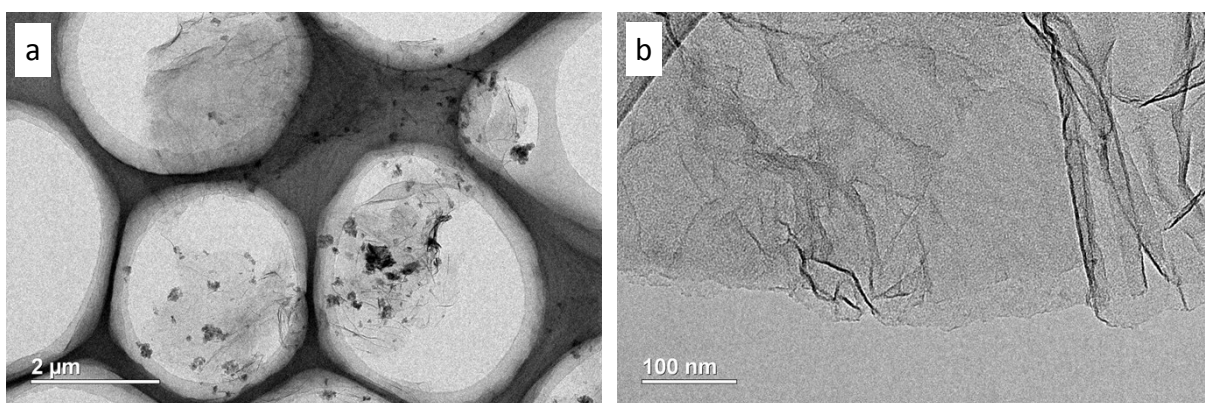


Figure S1. TEM of GO nanosheet

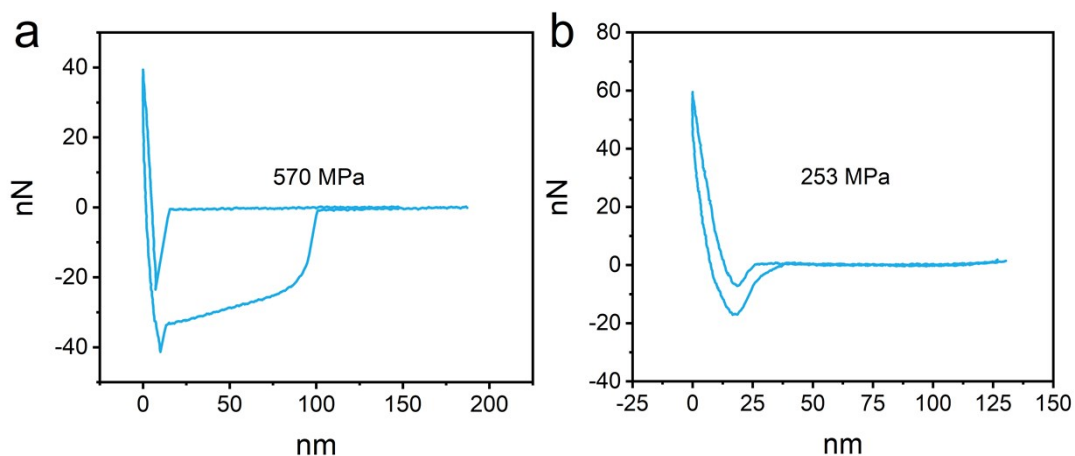


Figure S2. The mechanical properties of (a) MAP with GO and (b) MAP without GO via AFM characterization.

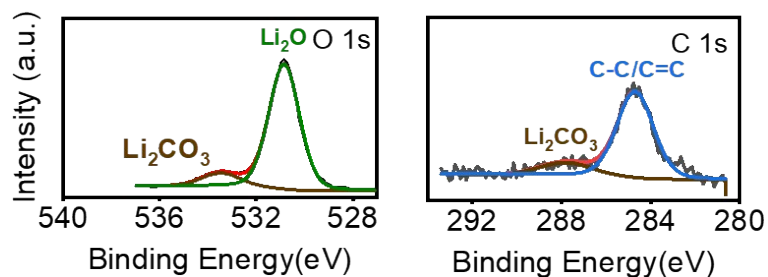
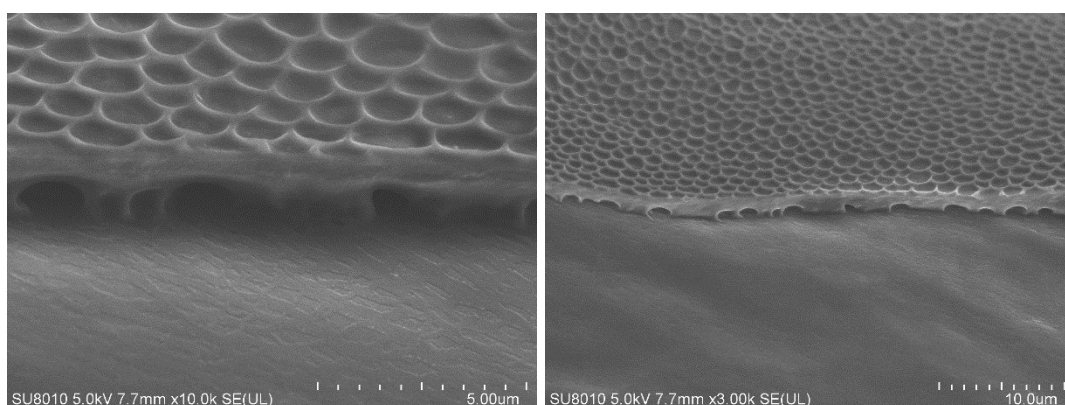


Figure S3. The O 1s and C 1s spectra of pristine Li.

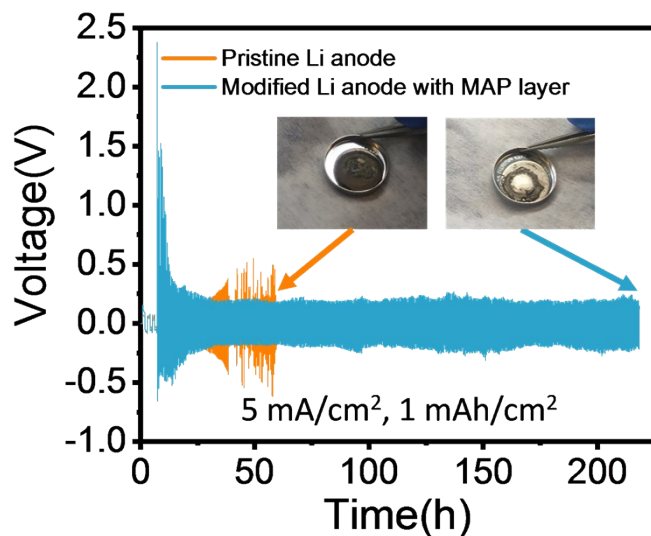


**Figure S4.** Cross sectional SEM of a MAP-modified lithium anode.

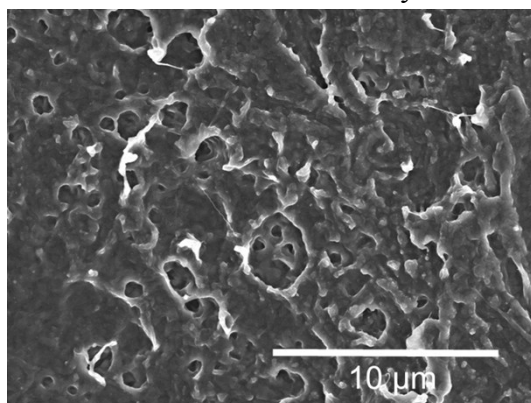
**Table S1.** The cycle life of different kinds of lithium anode modified with a SEI in a carbonate liquid electrolyte

Artificial SEIs	Test condition	Cycle life	Reference
graphite fluoride	1 mA cm <sup>-2</sup>	250 h	[1]
PAA	0.5 mA cm <sup>-2</sup>	700 h	[2]
	1 mA cm <sup>-2</sup>	250 h	
ZnO/PVDF-HFP	0.5 mA cm <sup>-2</sup>	500 h	[3]
Li <sub>3</sub> PO <sub>4</sub>	0.5 mA cm <sup>-2</sup>	900 h	[4]
NiF <sub>2</sub>	0.5 mA cm <sup>-2</sup>	1000 h	[5]
poly((N-2,2-dimethyl-1,3-dioxolane-4-methyl)-5-norbornene-exo-2,3-dicarboximide)	1.0 mA cm <sup>-2</sup> 0.5 mAh cm <sup>-2</sup>	300 h	[6]
SBR/Li <sub>3</sub> Sb	1.0 mA cm <sup>-2</sup>	500 h	[7]
organic alucone/Al <sub>2</sub> O <sub>3</sub>	1 mA cm <sup>-2</sup>	900 h	[8]
<b>This work</b>	1 mA cm <sup>-2</sup>	> 1100 h	

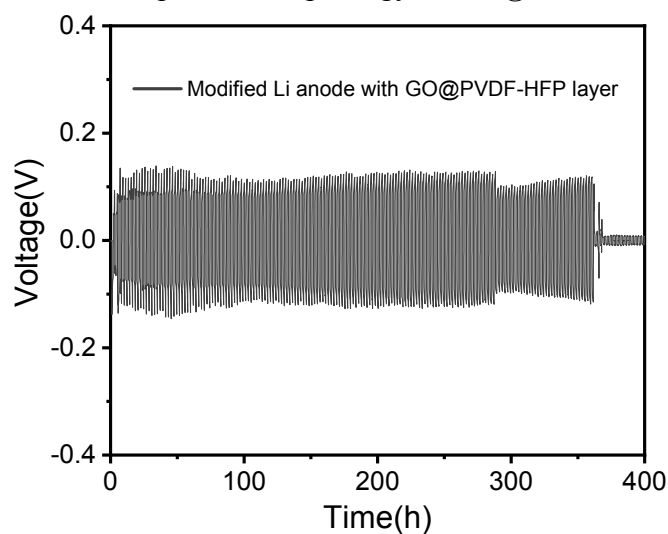
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**Figure S5.** Comparison of the long-term cycling stability of Li/Li symmetric batteries with a pristine Li anode and a Li anode modified with a MAP layer at  $5\text{ mA/cm}^2$  and  $1\text{ mAh/cm}^2$ .

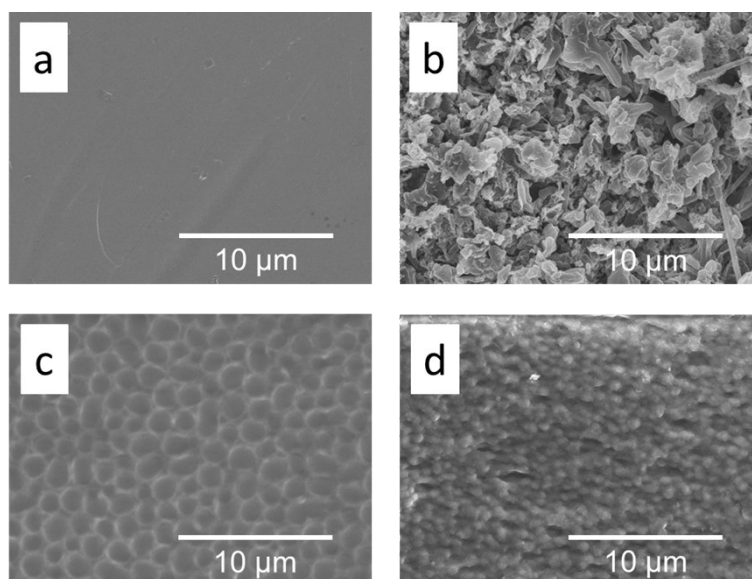


**Figure S6.** The top-view morphology of GO@PVDF-HFP layer.

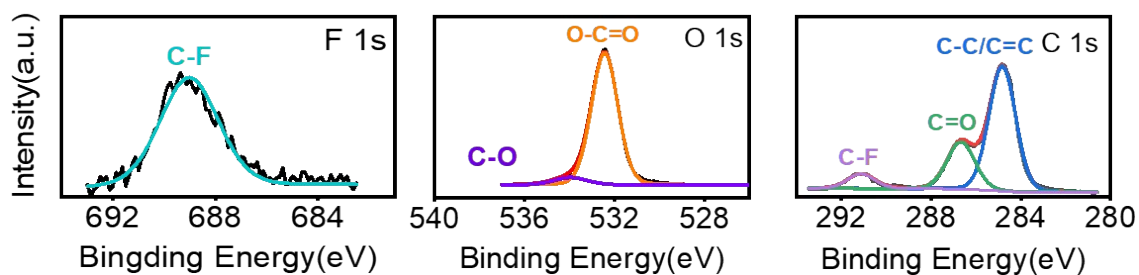


**Figure S7.** Voltage profile of continuous Li plating/stripping cycling of symmetric cell assembled with GO@PVDF-HFP-Li anode at a current density of  $1\text{ mA}\cdot\text{cm}^{-2}$  and a capacity

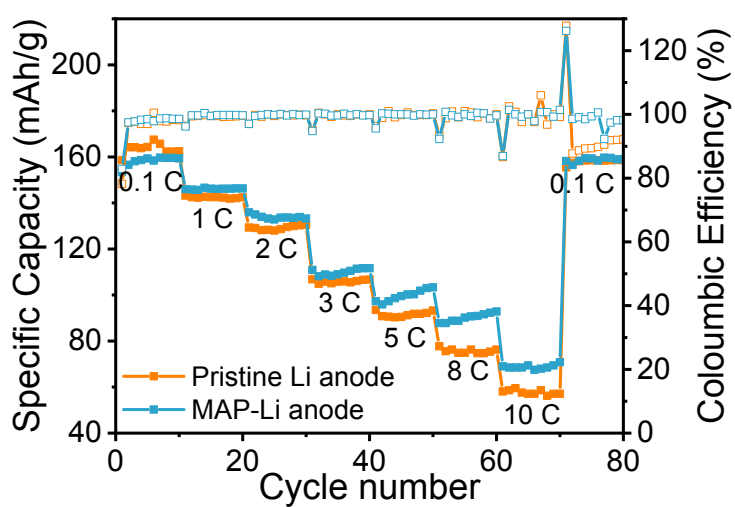
of  $1 \text{ mAh}\cdot\text{cm}^{-2}$ .



**Figure S8.** The magnified images of uncyclized (a) and cyclized (b) pristine Li metal, and uncyclized (c) and cyclized (d) MAP-Li anodes.



**Figure S9.** The O 1s, C 1s, and F 1s spectra of MAP layer.



**Figure S10.** Comparison of the rate performance of  $\text{LiFePO}_4/\text{Li}$  cells with pristine and modified Li anodes.