

## Supplementary Information

### Guiding lithium growth direction by Au coated separator for improving lithium metal anode

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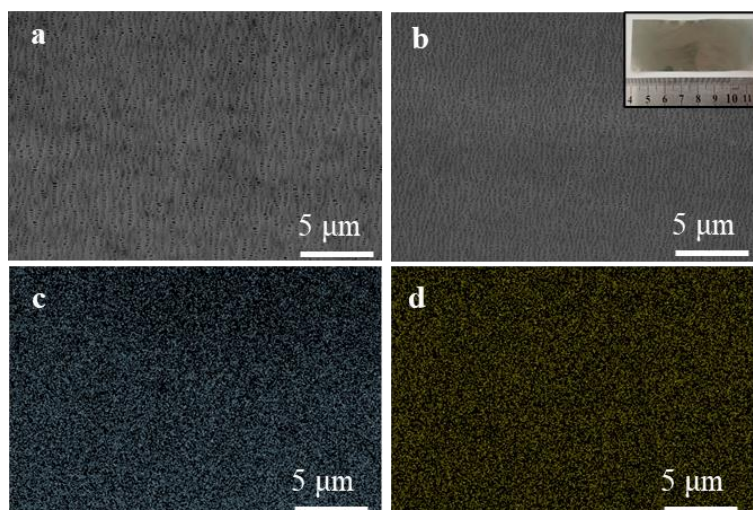
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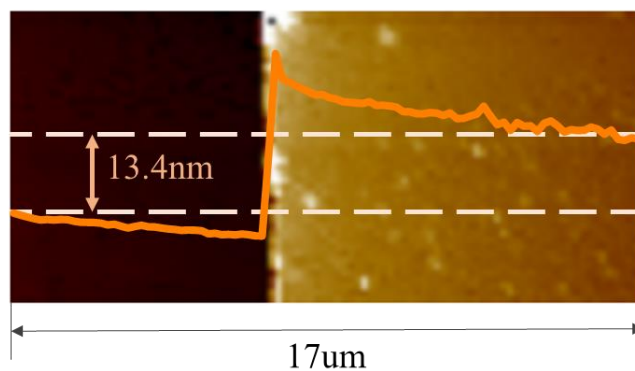
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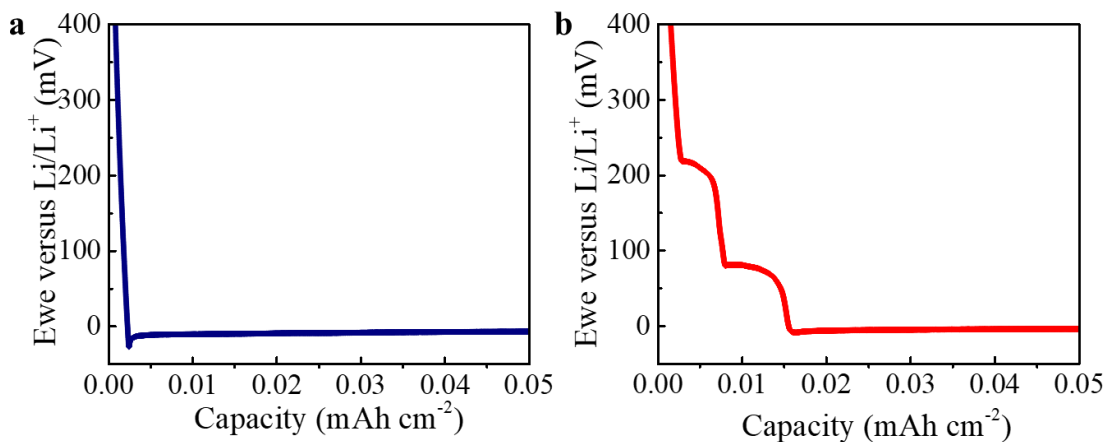
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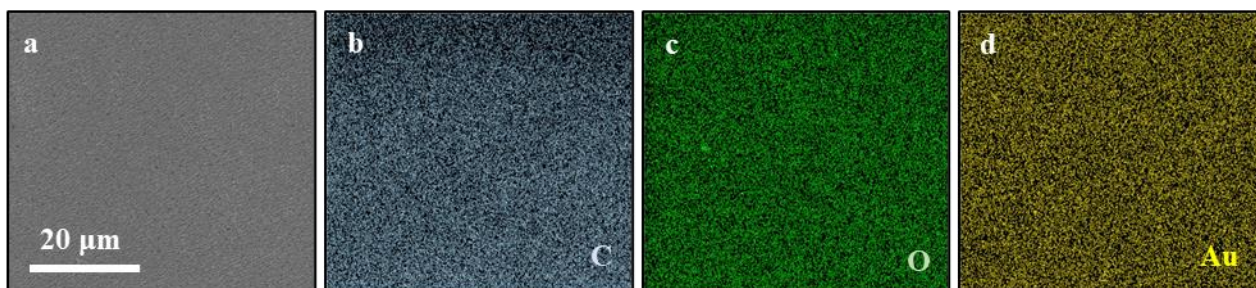
**Supplementary Figure 1.** Morphology and element mapping of commercial PP separator and AuPP. (a) SEM image of PP. (b) SEM image of AuPP (inset: digital photo of prepared AuPP). EDS mapping images of (c) C and (d) Au.



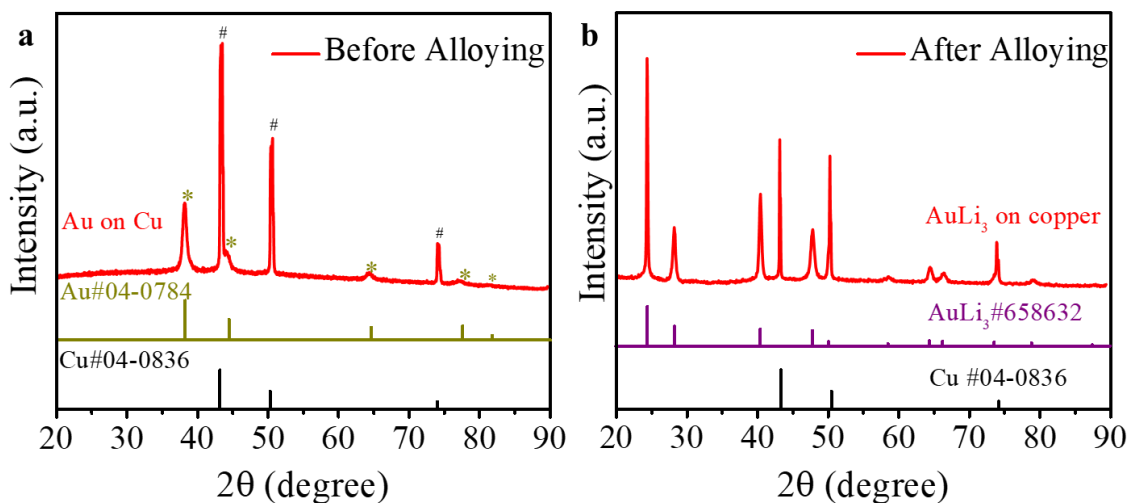
**Supplementary Figure 2.** AFM image and spectrum of relative height of the stepped thickness of sputtered Au and underlying Si substrate.



**Supplementary Figure 3.** Voltage profiles of lithium deposition on the (a) Cu and (b) AuPP at a current density of 10  $\mu\text{A cm}^{-2}$ .

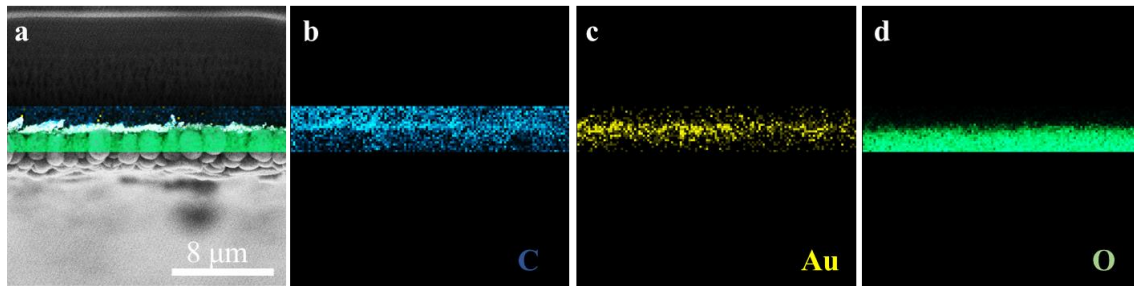


**Supplementary Figure 4.** (a) SEM image of only alloy (AuLi<sub>3</sub>) on the AuPP (cutoff voltage is set to 0.001 V) and mapping images of (b-d) C, Au, O.

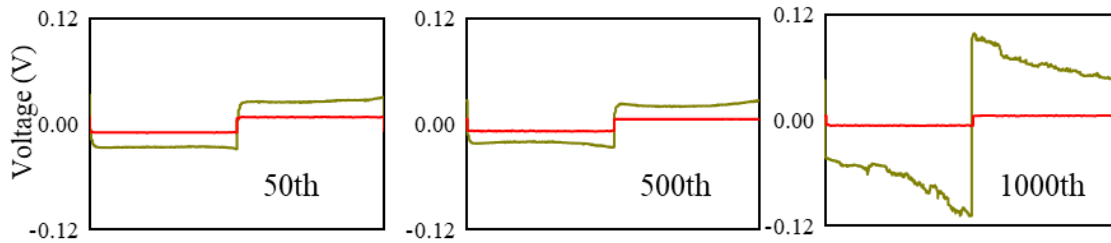


**Supplementary Figure 5.** XRD Spectrums of Au, Cu, alloyed AuLi<sub>3</sub> on copper (a) before

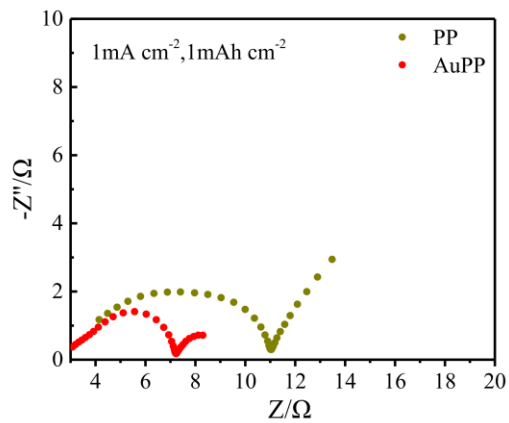
and (b) after alloying.



**Supplementary Figure 6.** (a) SEM image of cross-section view of deposited Li ( $0.5 \text{ mA h cm}^{-2}$ ) on the AuPP. Mapping images of (b-d) C, Au, O.



**Supplementary Figure 7.** Voltage profiles of symmetric Lithium cells with PP and AuPP in the 50<sup>th</sup>, 500<sup>th</sup> and 1000<sup>th</sup> cycle.



**Supplementary Figure 8.** Electrochemical impedance spectra of Li|Cu cells with PP and AuPP after 100 cycles for  $1 \text{ mA h cm}^{-2}$  at  $1 \text{ mA cm}^{-2}$ .