Electronic Supplementary Information

Synthesis of copper oxide nanowires and nanoporous copper via environmentally friendly transformation of bulk copper-calcium alloys

X. Zhang,[a,b]† K. Turcheniuk,[a]† B. Zusmann,[a] J. Benson,[a] S. Nelson,[a] S. Luo,[a] A. Magasinski[a] and G. Yushin[a,d]

[a] School of Materials Science and Engineering, Georgia Institute of Technology, Atlanta, GA 30332, USA.
[b] Huaihai Institute of Technology, People's Republic of China.
[c] Chongqing University, 55 Daxuecheng S Rd, Shapingba Qu, Chongqing Shi, China.
[d] Sila Nanotechnologies Inc, Alameda, California, 94501, United States.
† These authors contributed equally.

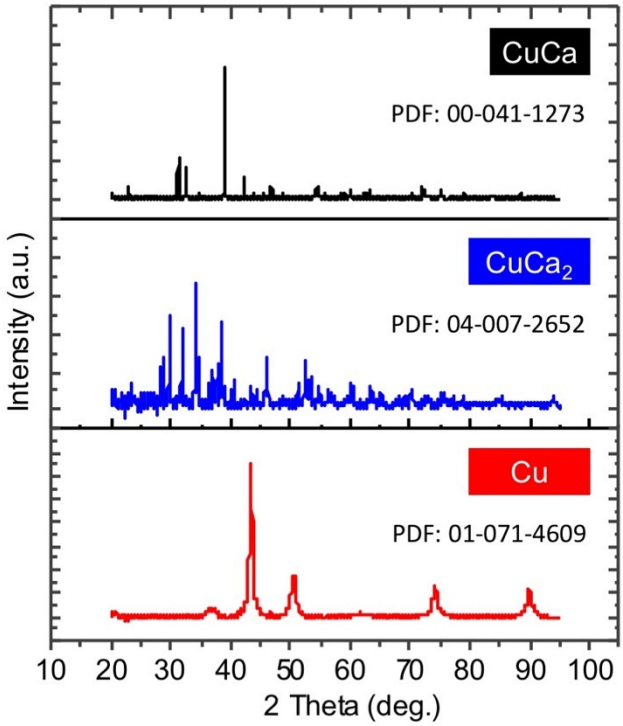


Fig. S1 X-ray diffraction of (A) CuCa; (B) $CuCa_2$; (C) NPCu.

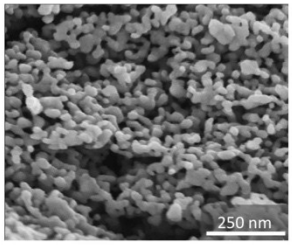


Fig. S2 SEM micrograph of NPCu obtained via $CuCa_2$ de-alloying

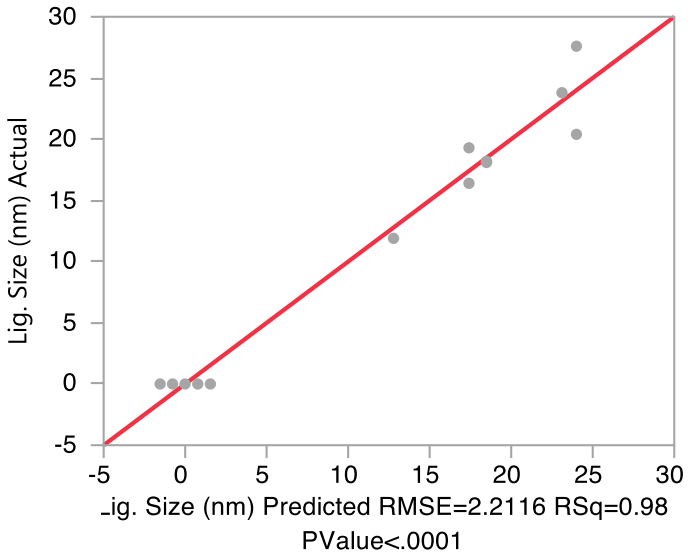


Fig. S3 Ligament length model: JMP model was shown to be highly predictive with an R-squared value of 0.98, root mean squared error (RMSE) of 2.212, and a statistically significant whole model p-value as shown in the actual by predicted plot.

Table S1, Parameter estimates for ligament length model of NPCu.

Term	Estimate	Std Err.	t Ratio	Prob>|t|
Intercept	23.9436	1.2130	19.74	<.0001*
Temp. (25,60)	-1.7306	0.5938	-2.91	0.0195*
Time h(12,72)	2.31430	0.6332	3.65	0.0064*
pH(1,14)	5.61624	0.7721	7.27	<.0001*
Alloy [CuCa]	-4.2687	0.5697	-7.49	<.0001*
Temp. *pH	-4.0735	0.8326	-4.89	0.0012*
pH*pH	-23.368	1.6785	-13.92	<.0001*
Temp. *Alloy [CuCa]	5.42335	0.7866	6.89	0.0001*

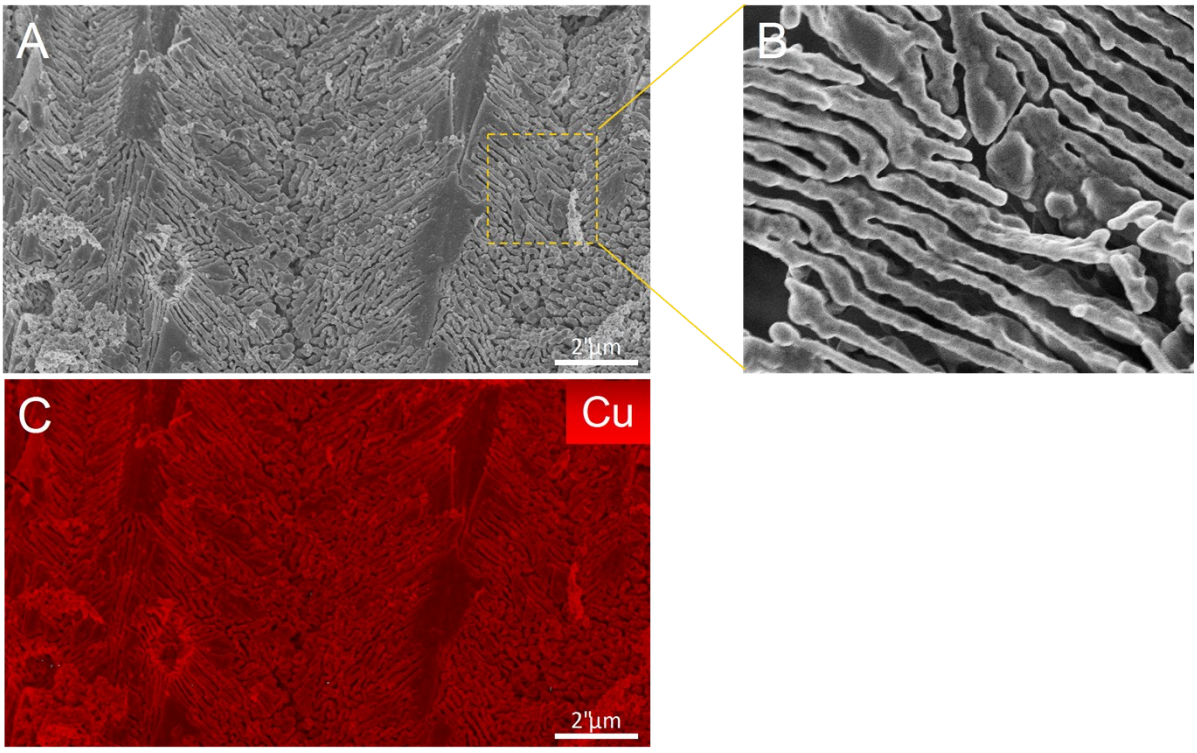
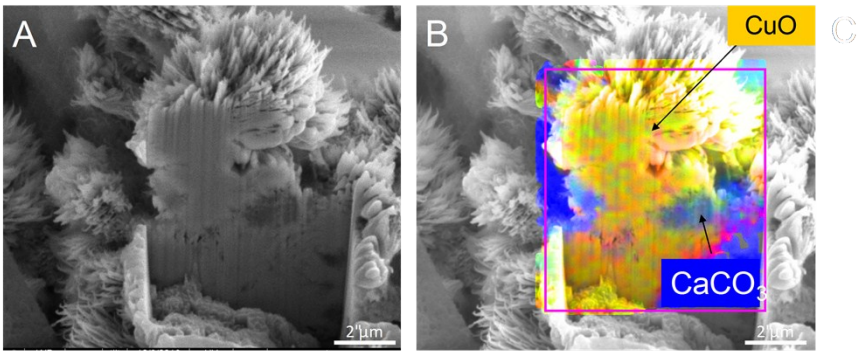


Fig. S4 (A)-(B) SEM micrographs and (C) mapping of Cu nanostructure obtained after de-alloying of CuCa alloy at pH 1 at 25 °C



C

Element	Wt%	At%
C-K	2.15	6.51
O-K	20.68	47.08
Si-K	1.70	2.20
Ca-K	3.76	3.41
Cu-L	65.59	37.60
Ga-L	6.12	3.20

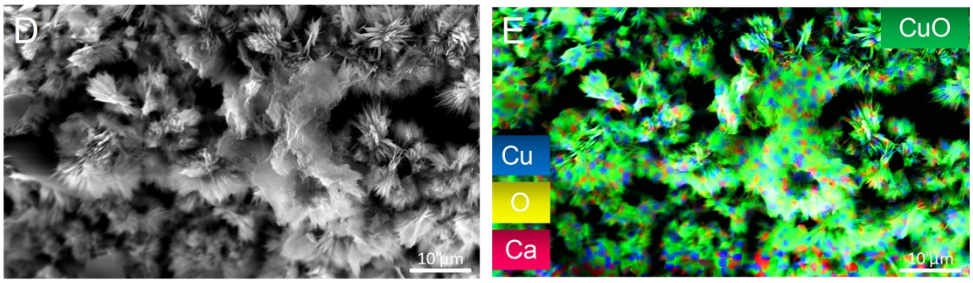
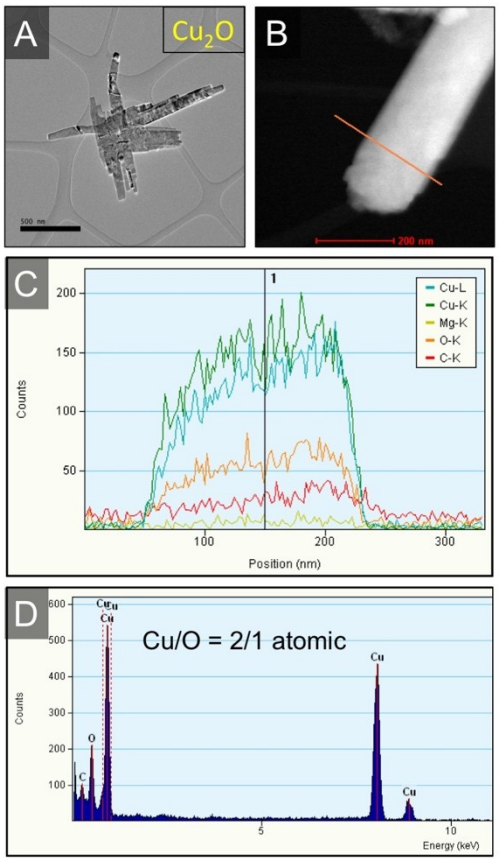


Fig. S5 SEM micrograph (A) and FIB cut EDS mapping (B) of CuO nanoneedles; (C) elemental composition of the CuO nanoneedles: Si and Ga signal are due to the contamination of the specimen. (D) SEM micrographs and (E) EDS of copper oxide nanoneedles obtained by CuCa de-alloying at pH 7 in O_2/Ar.



[a] Fig. S6 TEM (transmission electron microscopy) micrograph (A) and STEM (Scanning transmission electron microscopy) of Cu_2O nanowires; (C) the elemental composition of the line scan of the Cu_2O nanowires (D) EDS of copper (I) oxide nanowire.

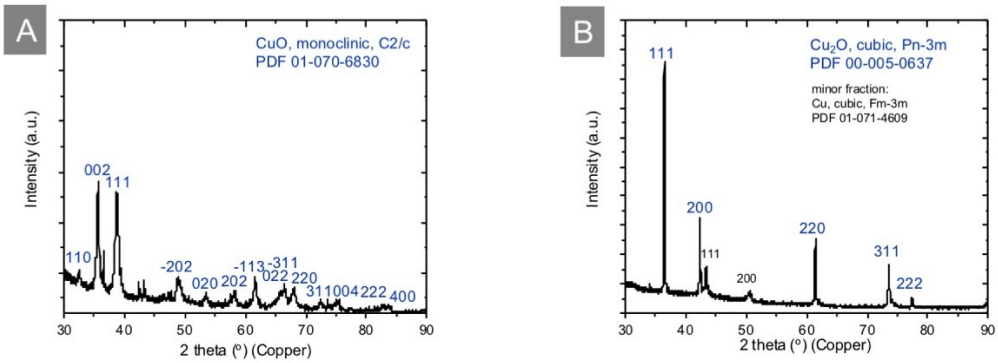


Fig. S7 XRD (X-ray diffraction) of as-synthesized (A) CuO NWs and (B) Cu_2O NWs.

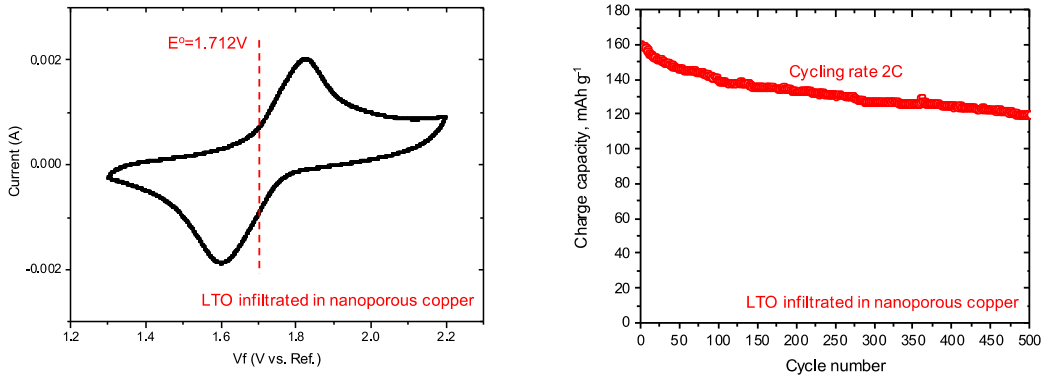


Fig. S8 (A) CV (cyclic voltammogram) and (B) charge capacity of the NPCu-LTO battery electrode.