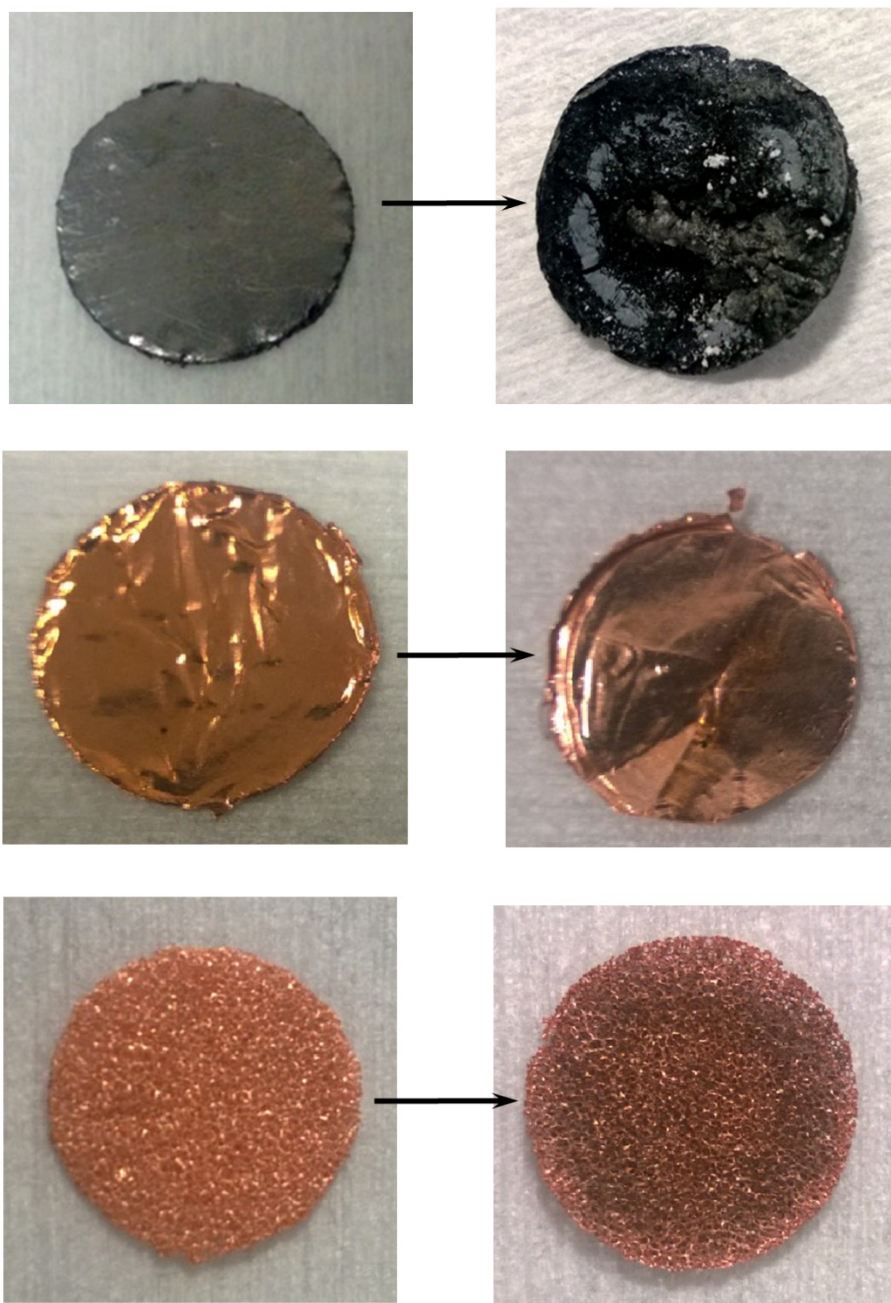
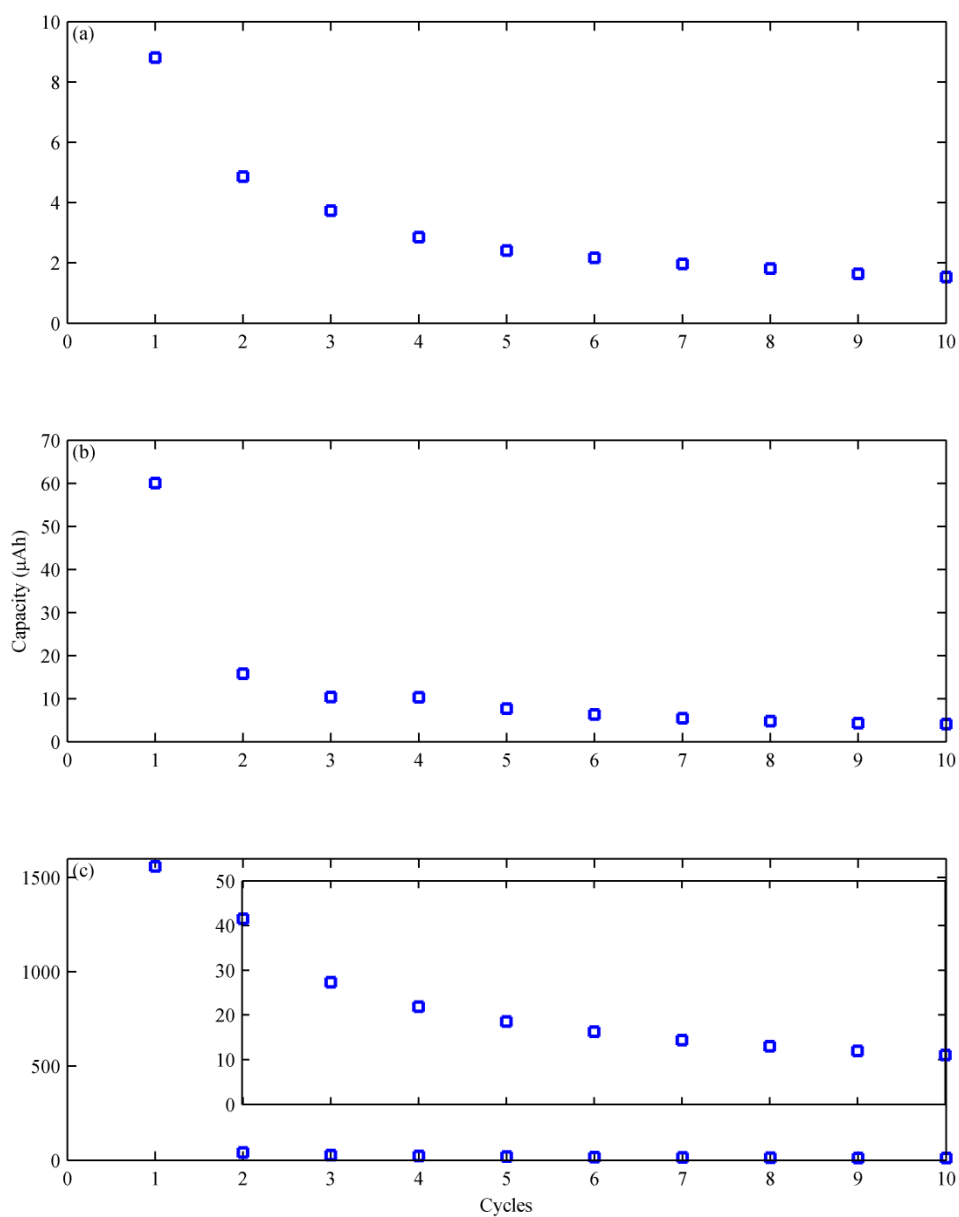


Supplementary materials



Supplementary Fig. 1 Unlike the monolayer graphene electrode (centre) or graphene on Cu foam (bottom) electrodes, the graphite paper electrode (top) has the mechanical damage of exfoliation after long time discharge tests due to Li^+ intercalation



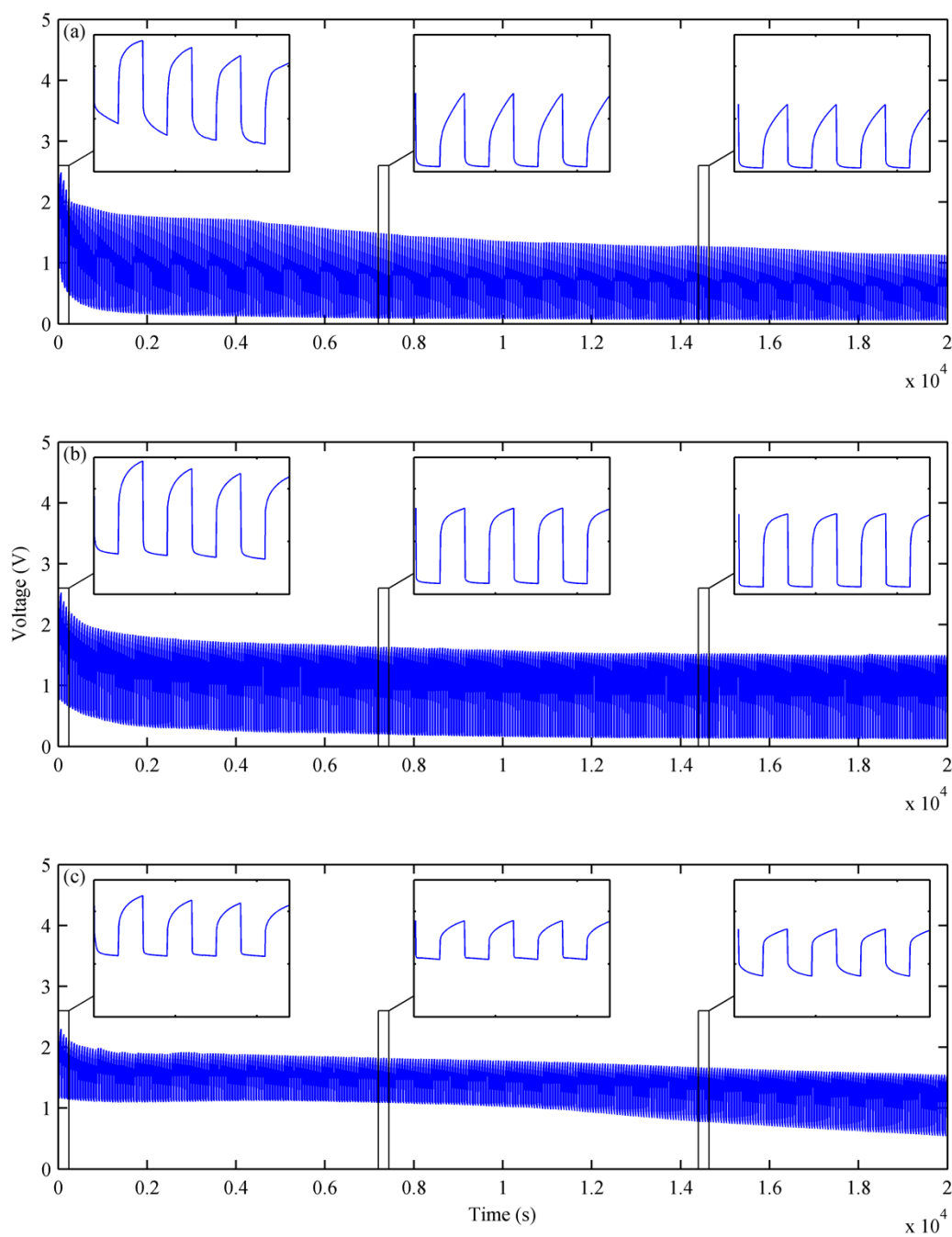
Supplementary Fig. 2 Energy capacities of batteries made from (a) monolayer graphene, (b) graphite paper and (c) graphene foam electrode; inset shows detail of graphene foam capacities (0.5mA discharge current)

It should be noticed that the gravimetric current value (A/g) applied on graphene electrode is actually much higher than that applied on graphite considering the huge mass difference .However,

we can still see stable energy capacities for graphene based electrodes, which indicates graphene based electrodes have much higher discharge-rate.

Estimation of mass of monolayer graphene can be done in the following way:

Thickness of monolayer graphene is 0.335 nm. Density of graphite is 2.267 g/cm³. Area of the coin cell is 3.14 cm². Thus for the monolayer cell the active material mass is 2.385×10^{-7} g, in contrast to the weight of graphite in the coin cell, ca.0.1 g. Thus if we changed to gravimetric energy capacities (mAh/g), all graphene based electrodes will have much higher energy capacity than graphite electrodes (Highest gravimetric energy density for monolayer graphene is 40 Ah/g, graphene foam is 41.3 Ah/g and graphite is 0.015 Ah/g).



Supplementary Fig. 3 Discharge through metal film resistor for batteries made from (a) monolayer graphene, (b) graphite paper and (c) graphene foam

Monolayer graphene	C_1 (F)	C_2 (10^{-4} F)	R_1 (Ω)	R_2 (Ω)	R_1C_1 (s)	R_2C_2 (s)
0.1 mA	0.0012	0.5022	5868.6	2959.0	7.04	0.148
0.25 mA	0.0019	0.5855	3640.9	2119.2	6.79	0.124
0.5 mA	0.0029	0.6625	2255.7	1424.3	6.54	0.094
Graphene foam						
0.1 mA	0.0089	1.1073	259.73	732.78	2.32	0.081
0.25 mA	0.0141	1.0559	213.16	690.87	3.01	0.073
0.5 mA	0.0169	1.1294	172.73	578.39	2.92	0.065
Graphite paper						
0.1 mA	0.0127	2.5799	489.79	423.87	6.25	0.109
0.25 mA	0.0133	2.7441	454.95	397.75	6.05	0.109
0.5 mA	0.0139	3.0382	441.70	353.99	6.14	0.108

Supplementary Table 1 Average values from equivalent circuit fitting described in the text