Electronic Supplementary Material (ESI) for Sustainable Energy & Fuels.

Spray Coated Few-Layer Graphene as Aluminium Battery Cathode

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Supporting Information

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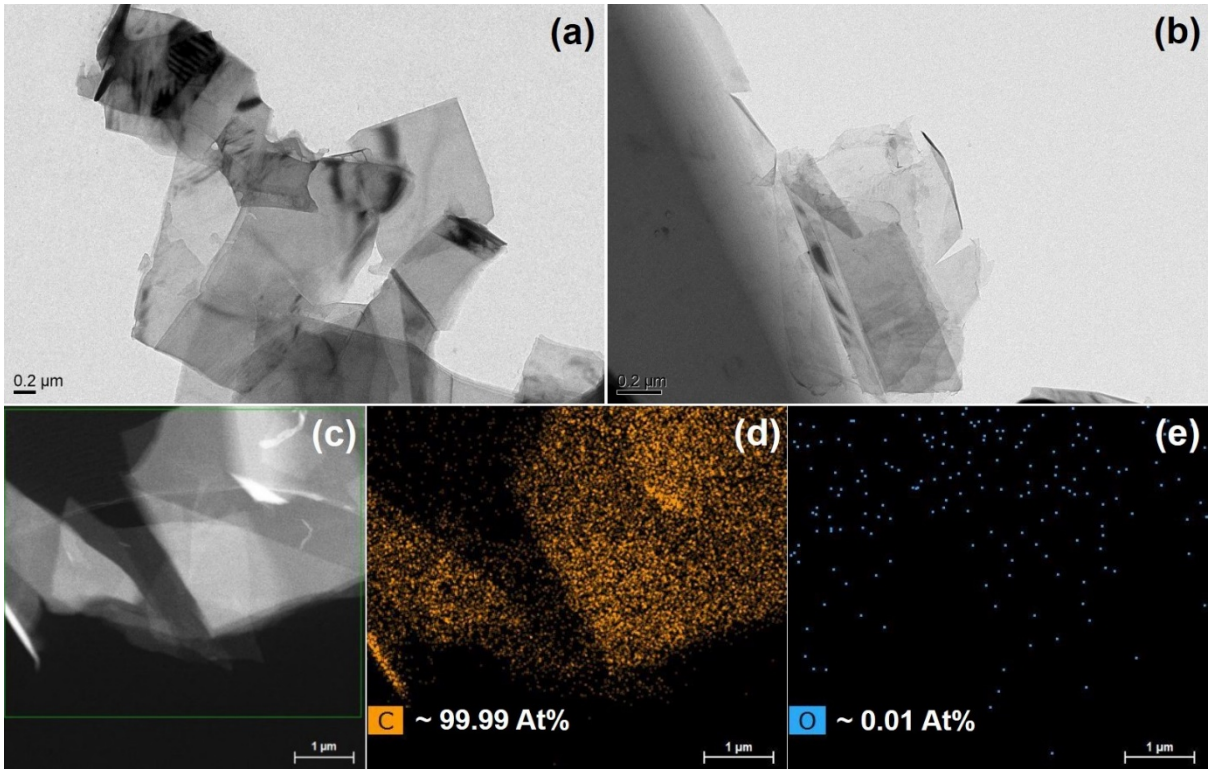

Figure S1. TEM images of GWJM: a) rectangular FLG sheets, b) edge features of a FLG sheet and c-e) elemental composition analysis of a FLG sheet.

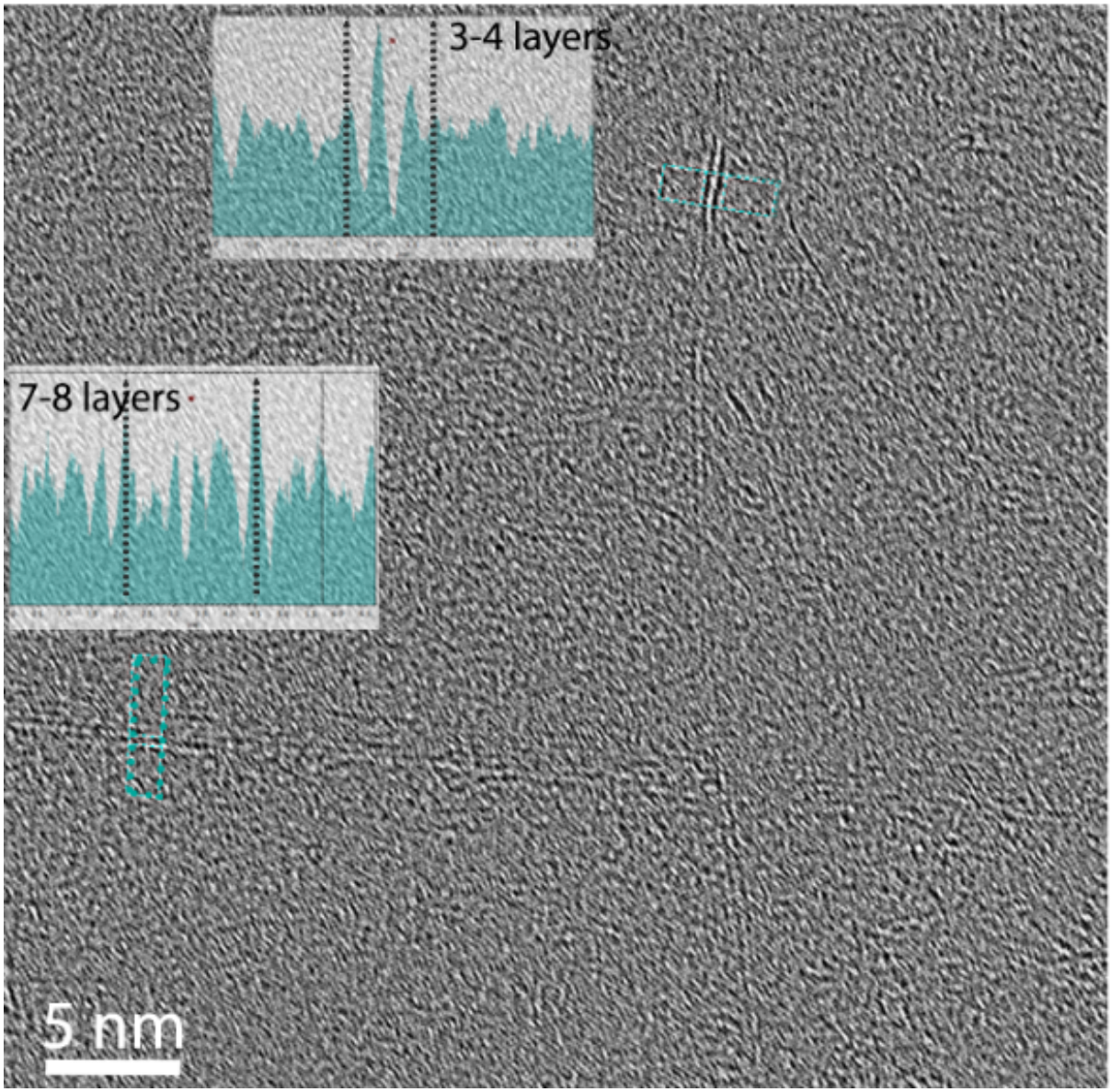

Figure S2. HRTEM image of an FLG sheets. The lines visible at the fold correspond to individual C layers within flake (graphite) spaced at about > 0.34 nm along the c-axis. Based on the intensity profiles across the folds (insets in the image) the two flakes were 3-4 and 7-8 monolayers thick.

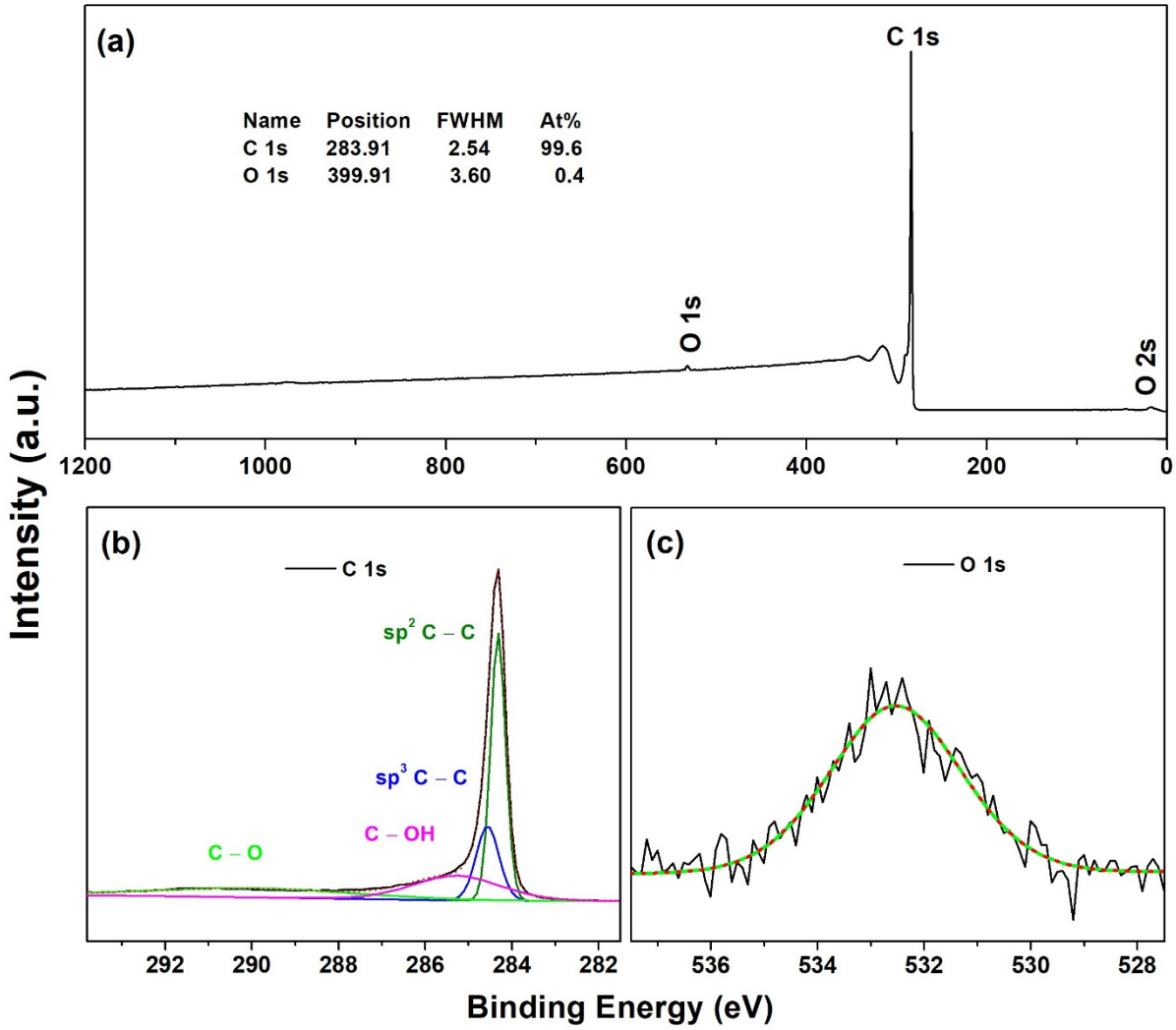

Figure S3. a) XPS survey spectrum and corresponding high resolution b) C 1s and c) O 1s spectra of GWJM.

Table 1. XPS analysis of GWJM.

Name	Bonding Mode	Position (eV)	FWHM* (eV)	At%
C 1s	C = C	284.32	0.40	40.56
	C – C	284.56	0.62	17.53
	C – OH	285.27	2.42	22.58
	C – O	289.97	5.61	19.33
O 1s	C – OH / C – O	532.54	2.91	100.00

** FWHM - full width at half maximum*

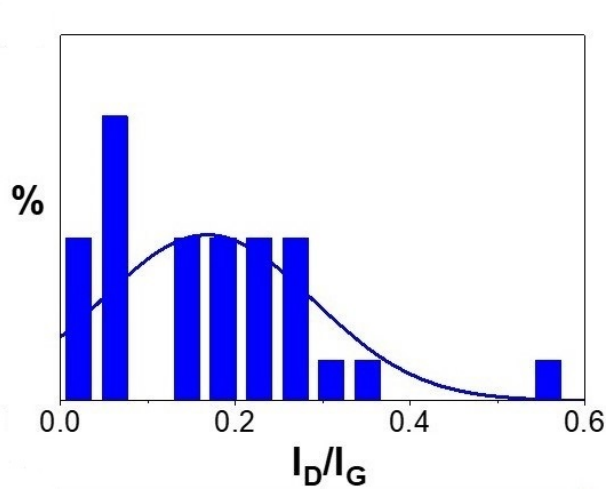

Figure S4. Raman statistical analysis of GWJM.

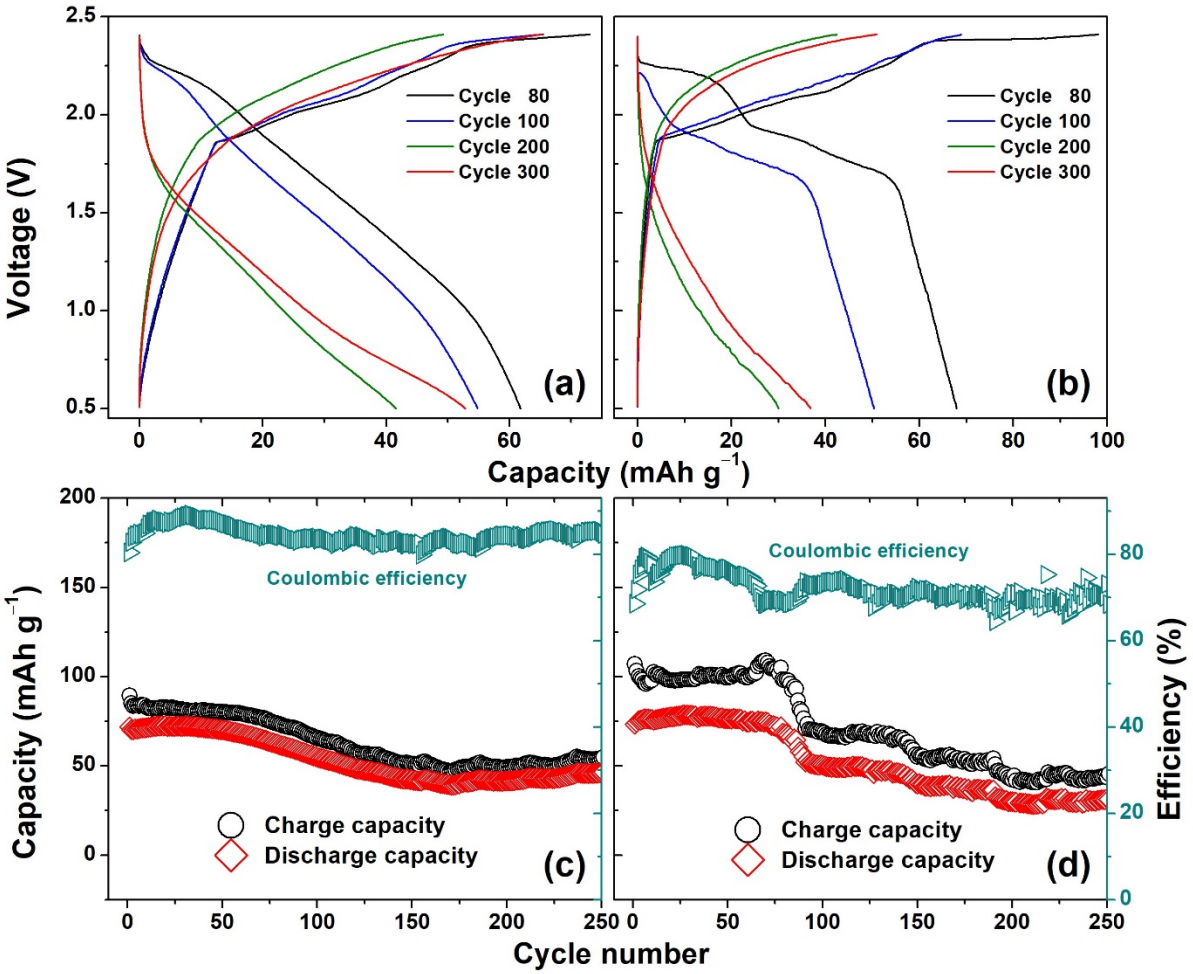

Figure S5. Charge-discharge profiles of a) GWJM, b) graphite, cyclic performance of c) GWJM and d) graphite.

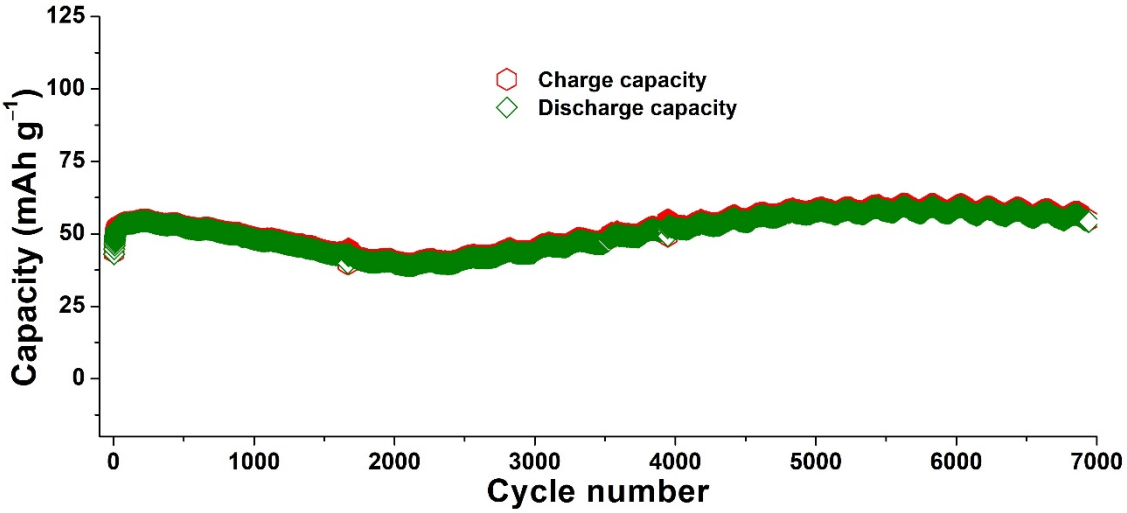

Figure S6. Long-term cyclability of 100 wt.% GWJM electrode at 1 A g ^{1} current rate.

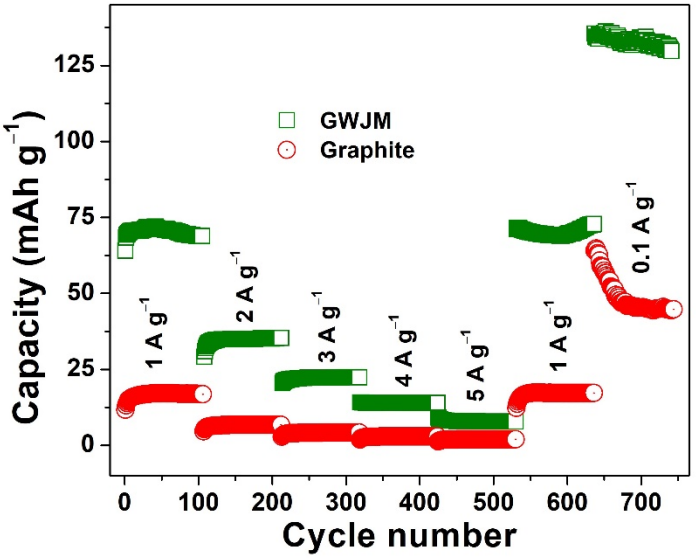

Figure S7. Rate capability of the graphite in comparison to GWJM.

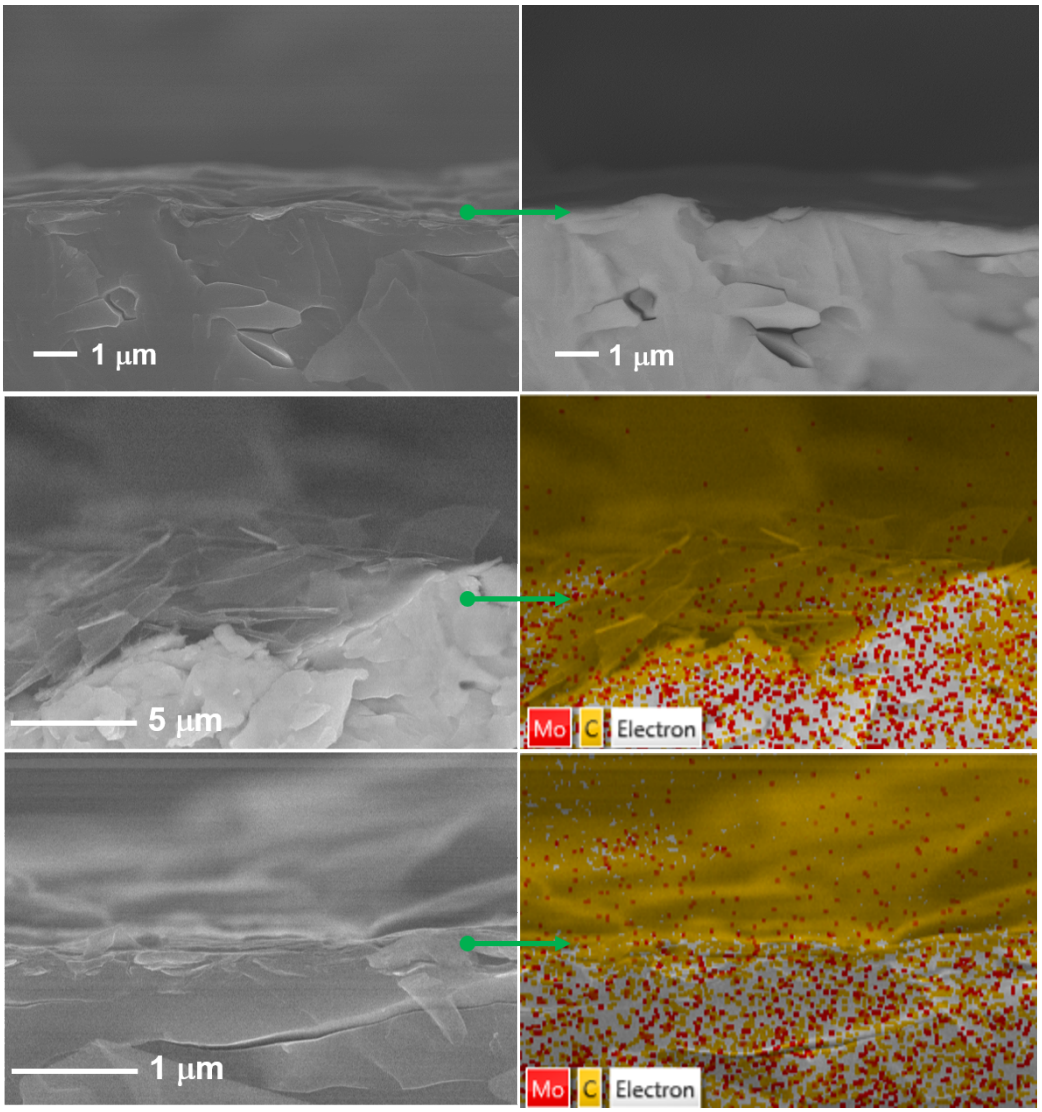

Figure S8. SEM cross-section view of spray-coated GWJM electrodes and corresponding elemental mapping. The thickness of the GWJM coating found in-between 1 – 5 µm.

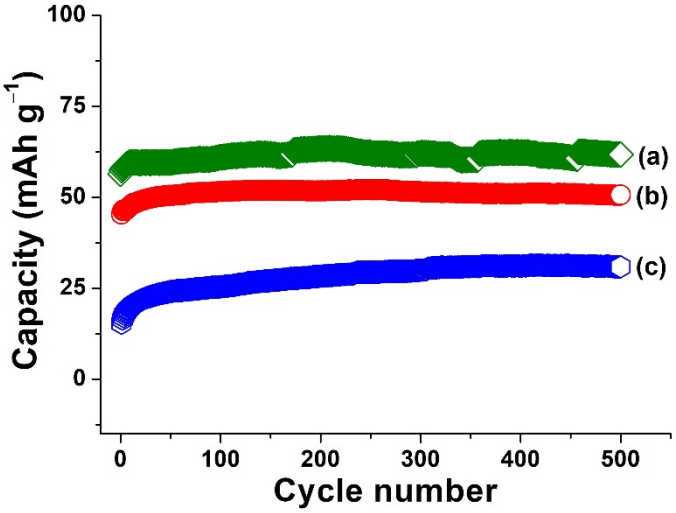

Figure S9. Charge capacity vs. mass (m) loading of GWJM at (a) m ≤ 2.0 mg cm ^{2}, (b) 3.0 < m < 5.0 mg cm ^{2} and (c) m > 5.0 mg cm ^{2} at 1.0 A g ^{1} current rate.

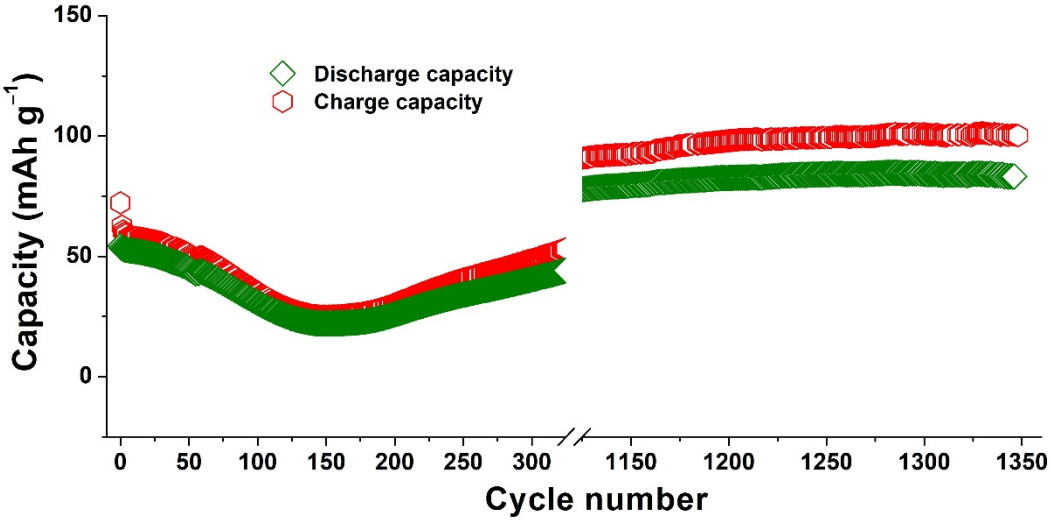

Figure S10. Cycling performance of GWJM at 70 °C and 1.0 A g ^{1} current rate.

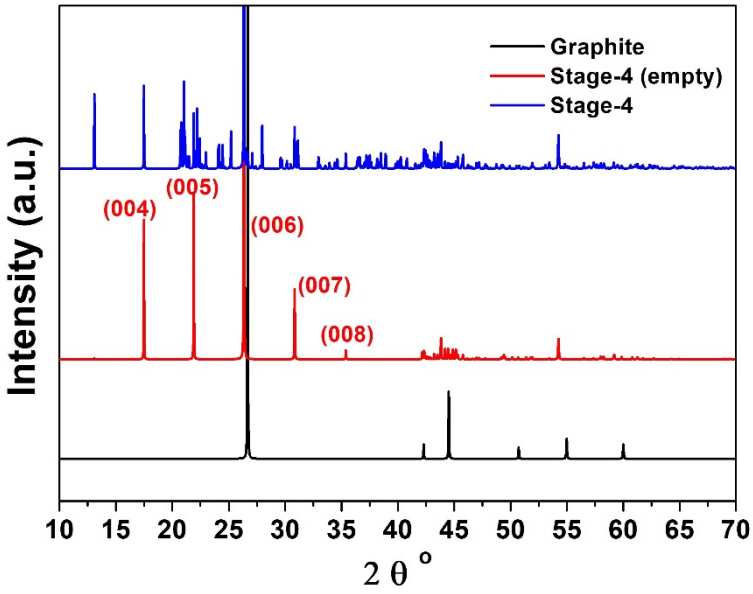

Figure S11. Theoretical XRD spectra of pristine (black) and stage-4 chloroaluminate-inserted graphite with (blue) and without (red) the inserted $AlCl_4^-$ anions, but no additional structure relaxation. The crystal planes corresponding to the reflections of the "empty" stage-4 graphite are indicated next to the respective peaks.

Table S2. Theoretical capacity and corresponding stages of chloroaluminate-inserted graphite.

Capacity (mAh g^{-1})	n(Al)	n(C)	stage
9	1	247.94078	30.9926
14	1	159.3905	19.92381
22	1	101.43032	12.67879
35	1	63.7562	7.96953
72	1	30.9926	3.87407
93	1	23.99427	2.99928
135	1	16.52939	2.06617

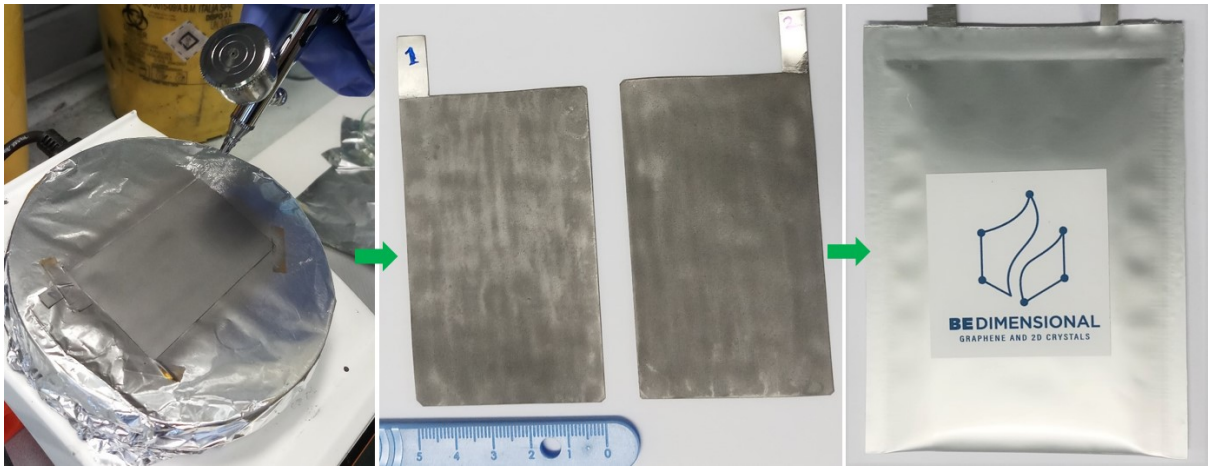

Figure S12. Spray-coting of GWJM electrodes (8.5 x 5.0 cm^2) which are used to fabricate a 5 Ah battery pack. The same pack is used to light red LED as shown below.