Electronic Supplementary Material (ESI) for RSC Advances.

A one-step process employing various amphiphiles for an electrically insulating silica coating on graphite

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Table S1. Experimental conditions of the 1-step process.

Graphite		Amphiphile		NH_4OH	TEOS		Media	Reaction time (with amphiphile adsorption time)
d50/d90 (μm)	Mass (g)	Mass (g)	Mass % of amphiphile input compared with graphite	Mass ratio of NH_4OH to TEOS	Mass (g) of 1st /2nd input	Mass % of 1st /2nd input compared with graphite	Volume (ml) of EtOH	Time (h)
12/25[1)] 23/55	5 5	0.50[2)]	10	1:3	4.0/2.0	80/40	75	12
100/140	5	0.25[3)]	5	1:3	6.0/0	120/0	75	12

1) Two different size of raw graphite, KS6 (d50 3.4 μm, d90 6.5 μm) and KS44 (d50 18.6 μm, d90 45.4 μm), were prepared with a mass ratio of 1:1.

2) The amphiphile used in the preparation of samples was Triton X-100.

3) The amphiphile used in the preparation of sample was PEG.

Table S2. The experiment conditions of the modified 1-step process ver.2.

Graphite		Amphiphile		NH_4OH	TEOS		Media	Reaction time	Thermal sintering
d50/d90 (μm)	Mass (g)	Mass (g)	Mass % of amphiphile input compared with graphite	Mass ratio of NH_4OH to TEOS	Mass (g) of $1^{st}/2^{nd}$ input	Mass % of $1^{st}/2^{nd}$ input compared with graphite	Volume (ml) of EtOH	Time (h)	Time (h)
12/25[1)]	5	0	0	1:3	4.0/2.0	80/40	75	12	5
12/25[1)]	5	0.50[2)]	10	1:3	4.0/2.0	80/40	75	12	5
23/55	5	0.50[2)]	10	1:3	4.0/2.0	80/40	75	12	5
100/140	5	0.25[3)]	5	1:3	6.0/0	120/0	75	12	5

[1)] Two different size of raw graphite, KS6 (d50 3.4 μm, d90 6.5 μm) and KS44 (d50 18.6 μm, d90 45.4 μm), were prepared with a mass ratio of 1:1.

[2)] The amphiphile used in the preparation of samples was Triton X-100.

[3)] The amphiphile used in the preparation of sample #57 was PEG.

Table S3. The experiment conditions for the full coverage

Graphite		Amphiphile		NH_4OH	TEOS		Media	Reaction time
d90 (μm)	Mass (g)	Mass (g)	Mass % of amphiphile input compared with graphite	Mass ratio of NH_4OH to TEOS	Mass (g)	Mass % compared with graphite	Volume (ml) of EtOH	Time (h)
25[1)]	5	0.5[2)]	10	1:3	6	120	75	3
55					5	100		
140					4	80		
550					4	80		

[1)] Two different sizes of raw graphite, KS6 (6 μm) and KS44 (44 μm), were prepared with a mass ratio of 1:1.

[2)] The amphiphile used in the preparation of the samples was PEG.

Table S4 . The surface resistivity of PVP-assisted silica@graphite, d50 = 100, 300 μm, via the two-step process

Graphite d50 (μm)	Surface resistivity (ohm/sq.)
100	10^2-10^3
300	10^2-10^3

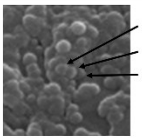
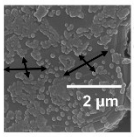
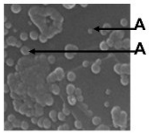
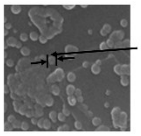
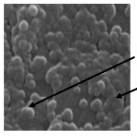
Categories	Details	1st pentagon (Inner)	2nd pentagon	3rd pentagon	4th pentagon	5th pentagon (Outer)	Examples
The protrusion of the particles	Comparing a particle in a range of average size, multiple numbers on Z-axis	1	1.5	1.5	2.5	Over 3.0	
The average size and frequency of empty area b/n the particles	Average of long length (nm) and short length for the channels / A number of channels	Under 0.1 / -	0.3 /under 5	0.3 / over 5	0.5 / over 5	Over 1 / over 5	
The difference in the size of the particles	Comparing the diameter of small and large particles, the multiple numbers	Under 1.5	1.5	2	2.5	Over 3	
The average size of the particles	The average size of the particles	Over 70	50-70	40-50	20-40	Under 20	
The progress of sintering b/n the particles	The average degree (%) of overlapping particles	Over 80	60-80	30-60	10-30	Under 10	

Fig. S1. Details for the five metrics. The characteristics of silica particles (or islands) are measured in a 4 um × 4 um square area on the graphite.

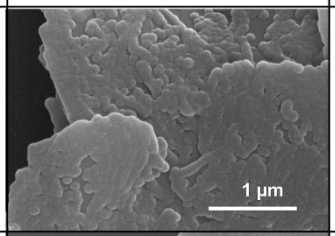
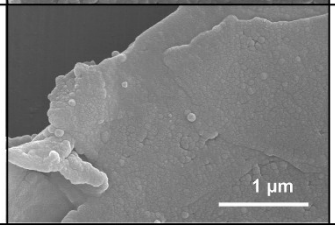
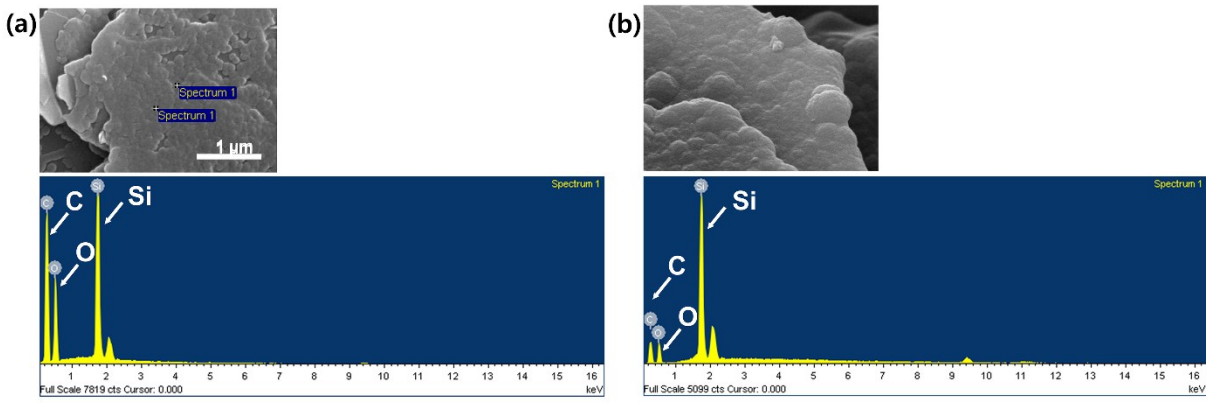
	Morphology	Surface resistivity (ohm/sq.)
Silica@graphite in absence of amphiphile		**10^{10}-10^{11}**
Triton X-100-assisted silica@graphite		**10^{12}-10^{13}**

Fig. S2. The micrograph and surface resistivity of silica@graphite (d50 = 12 µm) in the absence of an amphiphile and with the assistance of Triton X-100 (d50 = 12 µm).



Element	App (Conc.)	Intensity (Corrn.)	Weight %	Weight % (Sigma)	Atomic %
C	129.19	0.3047	58.22	0.41	66.88
O	71.90	0.2911	33.92	0.41	29.25
Si	51.03	0.8911	7.86	0.10	3.86
Totals			100.00		

Element	App (Conc.)	Intensity (Corrn.)	Weight %	Weight % (Sigma)	Atomic %
C	7.10	0.1635	51.43	1.11	63.81
O	6.24	0.2841	26.00	0.93	24.21
Si	17.72	0.9296	22.57	0.55	11.98
Totals			100.00		

Fig. S3. EDAX of (a) the Triton X-assisted silica@graphite (12 µm) and (b) the PEG-assisted silica@graphite (100 µm) vs. sol-gel reaction time.

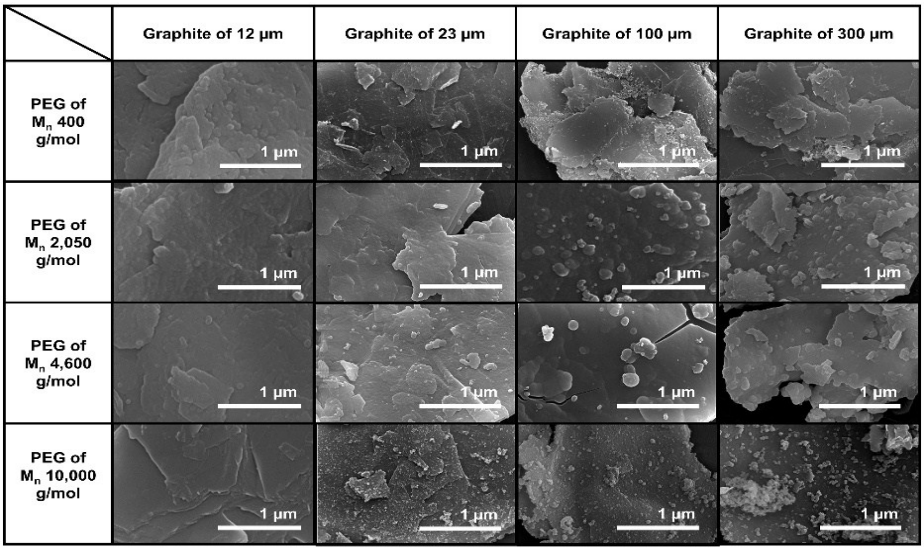


Fig. S4. FE-SEM images of the surfaces of PEG-assisted silica@graphite depending on the size of the graphite and M_n of PEG

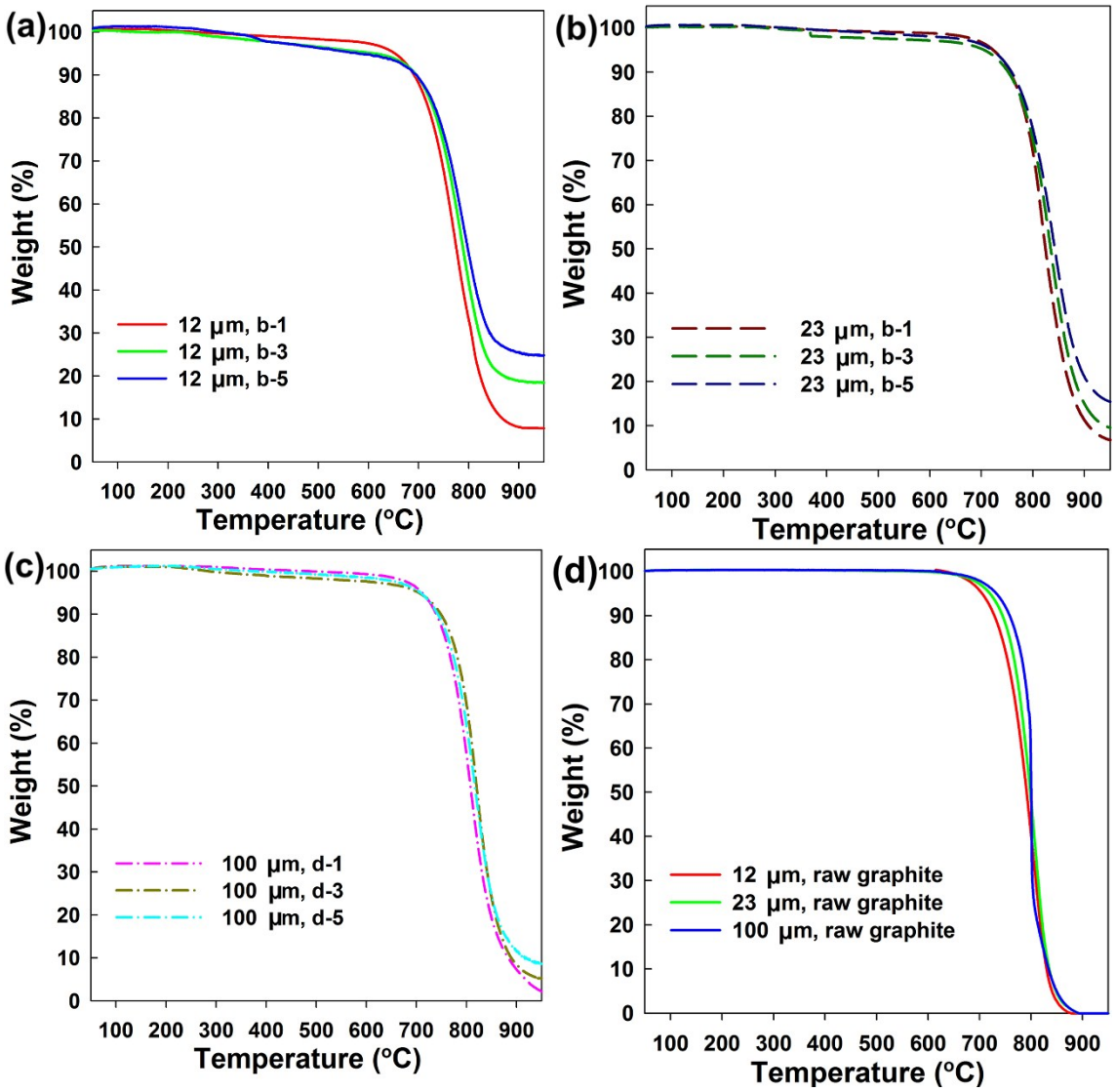


Fig. S5. Graphs of TGA analysis on (a) 12 µm amphiphile-assisted silica@graphite, (b) 23 µm amphiphile-assisted silica@graphite, and (c) 100 µm amphiphile-assisted silica@graphite (Relating to Fig. 11).