Supporting Information

Advanced anodes composed of graphene encapsulated nano-silicon in carbon nanotube network

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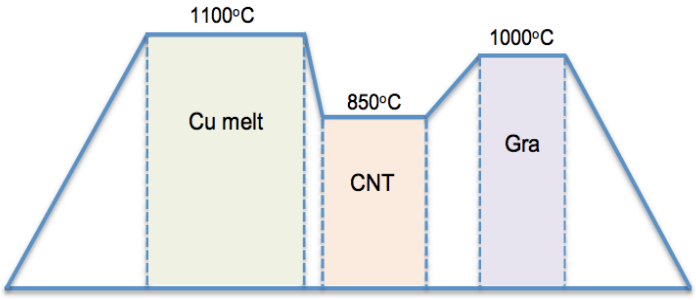

Fig. S1. The temperature variation for the whole experiment process.

Fig. S1 shows the whole experimental process with varied temperature step by step. Firstly, copper foil was thermal melt at 1100°C for about 60 min to form Si@Cu composite; Secondly, quickly cooled to 850°C for CNT growth; Finally, increasing the temperature to 1000°C again for the Gra growth.

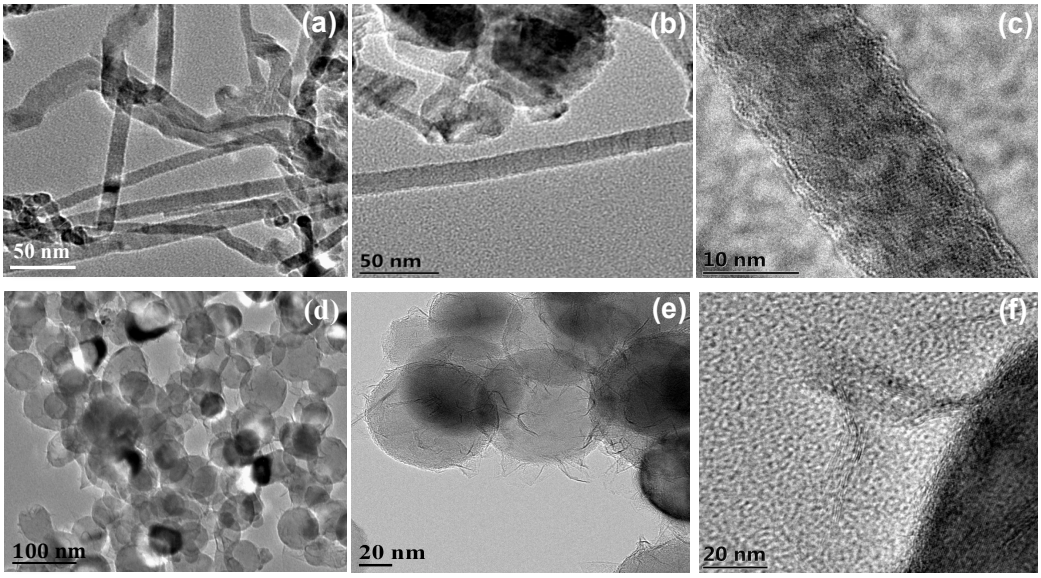

Fig. S2. TEM images for CVD obtained MWCNT (a-c) and Si@Gra composite (d-e).

Fig. S2 (a) shows a representative transmission electron microscopy (TEM) image of the obtained CNT in our current experiment. Fig. S2 (b) shows the CNT constructs between the silicon nanoparticles like a bridge, and the diameter of the obtained CNT is ~10nm as indicated in Fig. S2 (c), which a typical characterization for the multi-walled CNT (MWCNT). Fig. S2 (d, e) shows the low-resolution TEM (LR-TEM) image of the Si@Gra composite at different magnification, from the result, it can be seen that the silicon nanoparticles encapsulated Gra have good dispersion and no severe aggregation, most important, nearly each silicon nanoparticle is encapsulated uniformly by the crystalized Gra. Fig. S2 (f) shows the high-resolution TEM (HR-TEM) image of the edges of the Gra, which indicates the layer number of the synthesized Gra is mainly centered at 1~5 layers.

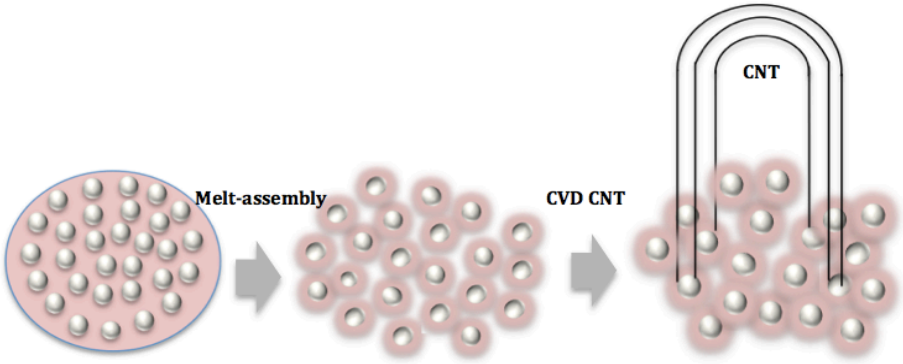

Fig. S3. Schematic diagram for the Cu melt-assembly to form Si@Cu composite, and the CNT synthesis using the nano-Cu as the catalyzer.

Fig. S3 shows the process for the experiment for CNT growth, first, the copper was melt and assembled outside the silicon nanoparticles to form Si@Cu nanocomposite, and then the CNT was obtained using the nano-copper as catalyzer.

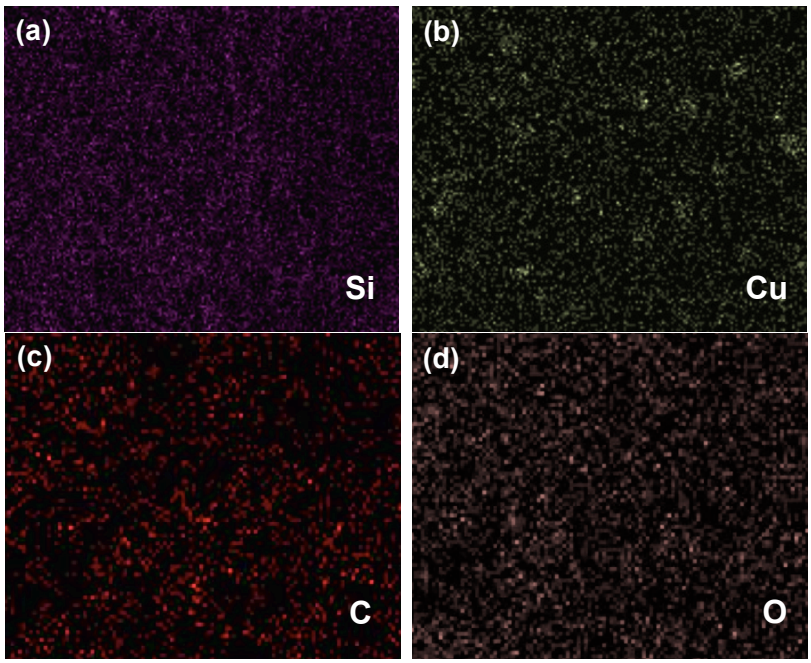

Fig. S4. FESEM-EDS mapping for the elements Si, Cu, C, and O in the Si@Cu, and Si@Gra@CNT composite.

Elemental mapping was performed using energy-dispersive X-ray spectroscopy (EDS) attached in the FE-SEM. The Silicon (purple), copper (green), graphene and carbon nanotube (wine red), and void (orange) can be found all over the samples, indicating the uniform distribution of the Gra, Si and CNT in the synthesized composite materials.

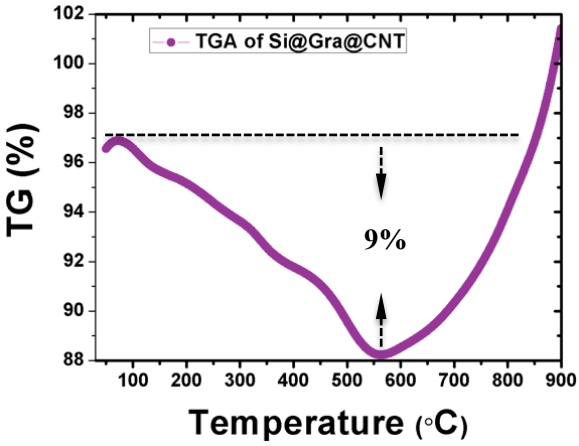

Fig. S5. TGA for the obtained Si@Gra@CNT

From the TGA result, it is found that the carbon content in the Si@Gra@CNT is increased to ~9% from our previously reported ~5% in the Si@void@mGra (ref.38).

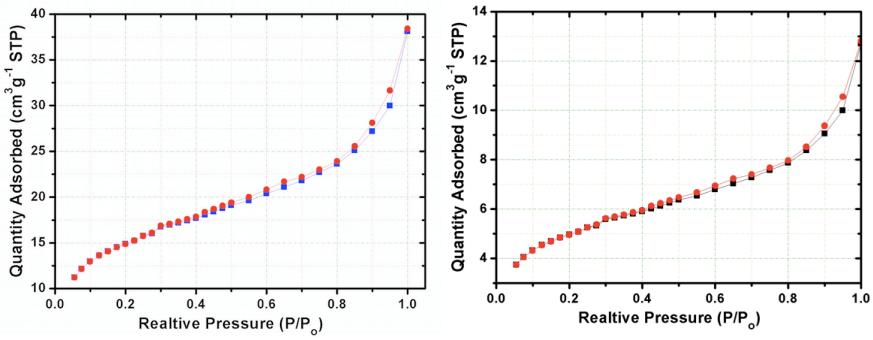

Fig. S6. BET result for the Si@Gra@CNT composite.

The Brunauer-Emmett-Teller (BET) surface area increase from 17.26 m^2 g^{-1} in Si@void@mGra (right, ref.38) composite to 32.87 m^2 g^{-1} in the Si@Gra@CNT (left, current work), and the carbon content increased from ~5% in the Si@void@mGra (ref.38) to ~9% in the Si@Gra@CNT (current work).

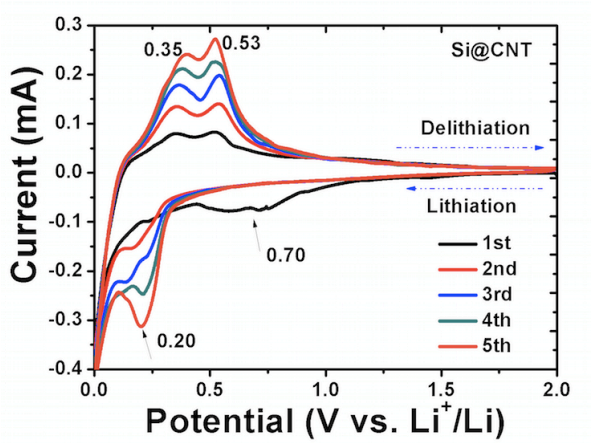

Fig. S7. CV curves for the Si@CNT

Fig.S7 shows the CV result for the Si@CNT anode in LIBs, the result is similar to the Si@Gra, but inferior to Si@Gra@CNT.