Supporting Information

Conductive Polyaniline Doped with Phytic Acid as Binder and Conductive Additive for Commercial Silicon Anode with Enhanced Lithium Storage Properties

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Figure S1. SEM and TEM images of (a-c) pristine SiNPs, (d-f) Si@SiO_x NPs and (g-i) PANi.



Figure S2. TG curve of Si@SiO_x.



Figure S3. The TEM images of (a) $Si@SiO_x-1$ h, (b) $Si@SiO_x-3$ h and (c) $Si@SiO_x-5$ h. (d) The cycling properties at 1 A g⁻¹ of $Si@SiO_x/PANi-100-1$ h, $Si@SiO_x/PANi-100-3$ h and $Si@SiO_x/PANi-100-5$ h anodes

The influence of SiO_x thickness on cycling performance. In order to display the influence of the SiO_x layer thickness on cycling performance of Si-based anodes, Si@SiO_x nanoparticles with controllable thickness of SiO_x layer are synthesized by adjusting the heating time at 600 $^{\circ}$ C in air. Si@SiO_x nanoparticles with heating time ranging from 1 h, 3 h to 5 h are produced and marked as Si@SiO_x-1 h, Si@SiO_x-3 h and Si@SiO_x-5 h, respectively. As shown in Figure S3, the SiO_x layer thicknesses of Si@SiO_x-1 h, Si@SiO_x-3 h and Si@SiO_x-5 h are about 2.3 nm, 3 nm and 3.2 nm, respectively. The prepared Si-based anodes are marked as Si@SiO_x/PANi-100-1 h, Si@SiO_x/PANi-100-3 h and Si@SiO_x/PANi-100-5 h, and the corresponding cycling performances are shown in Figure S3d. Although the specific capacity of Si@SiO_x/PANi-100-1 h electrode is higher than Si@SiO_x/PANi-100-3 h anode in the first few dozen cycles, it decreases more quickly in the following cycles, hinting worse cycling performance. Si@SiO_x/PANi-100-5 h electrode shows reduced reversible capacity because of the increased thickness of SiO_x layer. Undoubtedly, the optimal heating time is 3 h, and the produced Si@SiO_x/PANi-100-3 h anode in this work shows highest specific capacity and best cycling stability.



Figure S4. The EIS spectra of different Si@SiO_x/PANi anodes after two cycles.



Figure S5. Cyclability of the $Si@SiO_x/PANi-100$, $Si@SiO_x/PVDF$, and $Si@SiO_x/CMC$ electrodes at 0.5 (a) and 1 A g⁻¹ (b).



Figure S6. The mechanism of losing contact between conductive additive and Si active particles using CMC as binder.



Figure S7. The discharge capacity of pure PANi at 1 A g⁻¹.



Figure S8. (a) Survey scan, (b) Si 2p, (c) C 1s, (d) N 1s, (e) F 1s and (f) Li 1s XPS spectra of Si@SiO_x/PANi-100 after 500 cycles.



Figure S9. (a) FT-IR and (b) Raman spectra of Si@SiO_x/PANi-100 after 100 cycles.



Figure S10. The force-distance curves of peeling test for Si@SiO_x/PANi-100 electrode.

The adhesive properties of PANi. As a binder, the adhesive properties of PANi are investigated by peeling test. A 10-mm-wide and 30-mm-long electrode sample is attached to 3M tape, and the peel strength of the electrode specimens is measured with tensile machine (Microtester 5948, Instron). By pulling the tape at a constant displacement rate of 100 μ m/s, the applied load is continuously monitored and force-displacement plots are made. As shown in Figure 6, the initial peeling force is about 0.35 N, which is comparable to conventional PVDF

and CMC binders.^{1, 2} And binder ability of PANi should be further enhanced via adjusting the degree of acid doping and cross-linking of PANi, which is ongoing.

O content (wt. %)
2.61
6.89
8.23
8.99

Table S1. The O contents for $Si@SiO_x$ with different heating time at 600 °C.

Table S2. The EIS fitting values of different electrodes after 2 cycles

	Si@SiO _x /PANi-50	Si@SiO _x /PANi-100	Si@SiO _x /PANi-200
R _{sol} (ohm)	0.373	0.435	0.473
R _{ct} (ohm)	34.89	24.20	18.02

References

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