Supporting Information

1. Raw material characterization

Raw silicon was analyzed by FI-IR spectroscopy, and the result was shown in Fig. s1. As shown in Fig. s1, the two peaks at 3441.6 cm^{-1} and 1639.6 cm^{-1} are characteristic peaks of water, which are due to the ambient atmosphere. The characteristic peaks of silicon oxide appear at 1050.0 cm^{-1}, 981.6 cm^{-1} and 573.7 cm^{-1}, which indicates that part of the silicon is oxidized by air during the processing of silicon. The above conclusion is consistent with that of XPS (Fig. 4(d)). Silicon oxide can form lithium silicate with lithium, which is an important component of SEI and can affect the diffusion of Li^+ in electrodes. Therefore, it is very important to avoid oxidation of the silicon source during processing, and we will take this as an important direction for the next work.

In addition, particle size, morphology analysis, and elemental analysis were carried out in our previous works on raw silicon [1, 2]. The average size of silicon was about 400-500nm. The silicon particles are in a chip-grass structure and contain about 93% silicon and 7% oxygen.

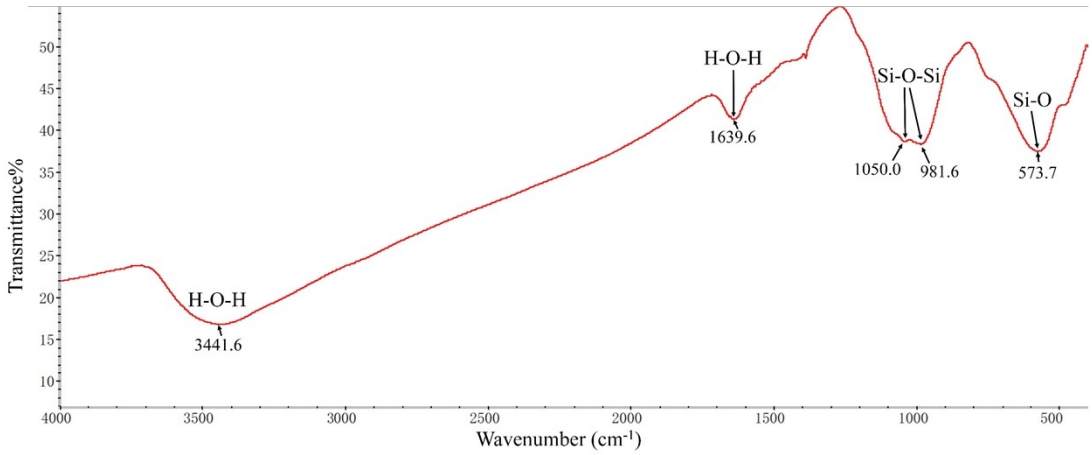

Fig. s1. FI-IR spectroscopy of raw silicon

2. Elemental analysis

The elements ratio of the samples is an important indicator to help evaluate their performance. The ratio of elements of samples tested by EDS was shown in Table s1.

Table s1 Ratio of element (Weight percentage%)

Sample	Carbon	Silicon	Oxygen	Copper
Si@C-Cu	53.4	30.2	10.1	6.3
Si@C	49.7	39.4	10.9	0

Reference

1. Z. Fan, S. Zheng, S. He, Y. Ye, J. Liang, A. Shi, Z. Wang and Z. Zheng, *Diam. Relat. Mat.*, 2020, **107**.

2. J. Liang, Z. Fan, S. Chen, S. Zheng and Z. Wang, *J. Alloy. Compd.*, 2021, **860**.