



Figure S1. CV curves of hematite Fe_2O_3 at the scanning rate of 0.1 mV s^{-1} in the range of $0.01\sim 3.5 \text{ V}$.

As shown in Figure S1, for the hematite Fe_2O_3 anode material, the reduction peak at 0.5 V corresponds to the multi-step reduction of Fe_2O_3 to Fe^0 according to Equations (S1) and (S2), which shifts to a reduction peak at around 0.7 V during the subsequent cycles, and presumably the disappeared reduction peak corresponds to the insertion of Li^+ into the irreversible site and the generation of the SEI layer. This reduction peak at 0.7 V together with the broad oxidation peak at $1.5\sim 2.5 \text{ V}$ during the charging process correspond to the characteristic peaks of the Li^+ insertion/extraction reactions in $\alpha\text{-Fe}_2\text{O}_3$ as shown in Equation (S3).

