A novel tin-graphite dual-ion battery based on the sodium-ion electrolyte with high energy density

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With the support by the National Natural Science Foundation of China and the Chinese Academy of Sciences, the research team led by Prof. Tang Yongbing (唐永炳) at the Functional Thin Films Research Center, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, developed a novel tin-graphite dual-ion battery based on sodium-ion electrolyte with high energy density, which was published online in *Advanced Energy Materials* (2016, DOI: 10.1002/aenm.201601963).

Lithium-ion batteries (LIBs) have been dominant power sources for portable electronic devices and show promising applications in electric vehicles. However, the limitation of lithium resources and high cost restrict further wide applications in future. Sodium-ion batteries (SIBs) are considered to be a promising alternative to conventional LIBs due to the abundance and low cost of sodium resources as well as similar physical and chemical properties to lithium. However, it is a barrier for the development of SIBs due to the lack of appropriate cathode and anode materials with reversible sodiation/desodiation as well as good rate and cycling performance. In addition, the energy density of SIBs is also hindered by the moderate capacity and working voltage.

In this study, Prof. Tang's group developed a novel tin-graphite dual-ion battery (named Sn-G DIB) based on a sodium-ion electrolyte, using Sn foil directly as both anode and current collector, and expanded graphite as cathode. It is worthy to note that the Sn-G DIB worked reversibly with high capacity in the sodium-ion electrolyte over a high voltage window of 2.0—4.8 V. This battery delivered 74 mAh g^{-1} at 2 C (1 C corresponding to 100 mA g^{-1}) current rate and kept stable for 400 cycles with 94% capacity retention as well as a high Coulombic efficiency of 95%. Moreover, as the Sn foil simultaneously acted as the anode material and the current collector, dead load and dead volume of the battery could be greatly reduced, thus the energy density of the battery was further improved. It exhibited a high energy density of 144 Wh kg^{-1} at a power density of 150 W kg^{-1}, and 111 Wh kg^{-1} at 793 W kg^{-1}, which were comparable with the commercial LIBs. Thus, with the merits of environmental friendliness, low cost, and high energy density, the Sn-G DIB shows attractive potential for future energy storage application.

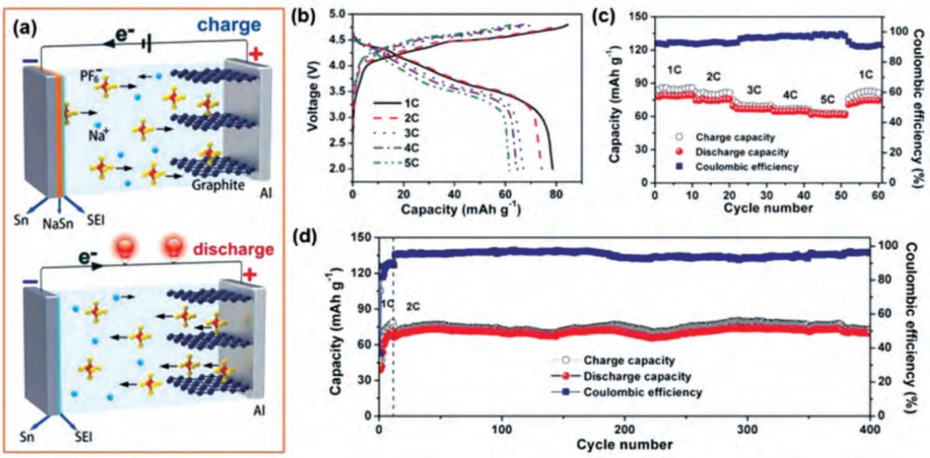

Figure Working mechanism and electrochemical performance of the Sn-G DIB based on the Na-ion electrolyte.