Nontopotactic Conversion Reaction in Highly Reversible Sodium Storage of Ultrathin Co_9Se_8/r-GO Nanosheets

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Na-ion batteries have recently experienced renewed interest as a potential energy storage alternative to Li-ion battery system due to the natural abundance and wider distribution of Na resources. Though many cathode materials have emerged as promising candidate in terms of energy density and electrochemical performance, one main obstacle to the commercialization of NIB is the limited choice of anode that can provide suitable stability and rate performance. [1-2]

We report Co_9Se_8 as anode materials for sodium ion battery. Co_9Se_8 was assembled via a modified solvent-induced oriented attachment method through controlling the ratio of precursors to graphene oxide. The obtained Co_9Se_8 anode delivers a highly reversible capacity of ~420 mAh g^{-1} showing evident plateau around 1.7 and 1.2 V respectively. The shift of the potential plateau after initial cycle can be related with the formation of SEI, which also induces large capacity fade. The rate performance of Co_9Se_8 anode is also promising (298 mAh g^{-1} at 5 A g^{-1}) compared with other anode materials. [3-5] Impressively the rate capacity of Co_9Se_8 is higher than that of any carbonaceous materials such as hard carbon and expanded graphite at any current rate. While its performance is also good compared with other transition metal selenides such as Cu_2Se. The excellent performance can be attributed to the following aspect: (1) the redox process may involve a nontopotactic reaction as shown in the Figure 1(e) during sodiation/de-sodiation that the materials break down to facilitate complete reduction of redox-active metal ion to elemental metal, therefore allowing for highly reversible capacity. (2) rGO may not only provides suitable site for oriented attachment growth of the candidate Co_9Se_8 but also prevent the stacking of nanosheets. (3) In addition, the active materials take the advantage of graphene nanosheets as an elastic and conductive matrix to effectively accommodate the volume strain during charge/discharge. (4) the unique feature of Co_9Se_8 such as excellent conductivity and large surface area make a promising candidate as anode for sodium-ion battery.

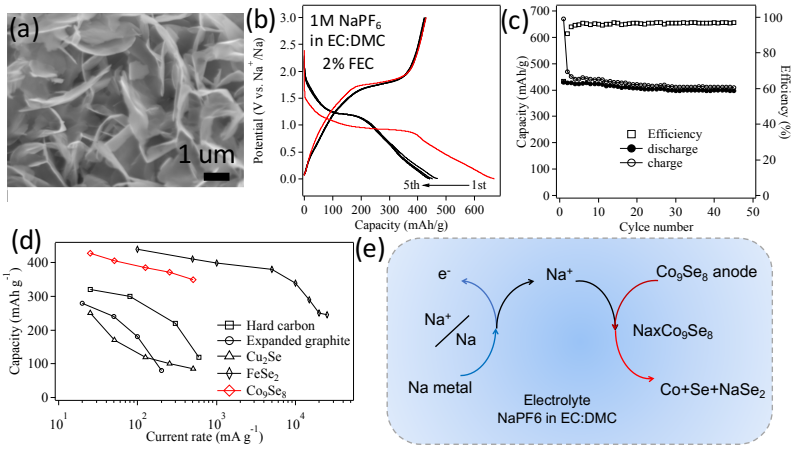

Figure 1. Morphology and electrochemical performance of Co_9Se_8/rGO as anode materials for NIB. (a) SEM image, (b) charge/discharge curves and (c) capacity retention performance at 50 mA g^{-1}, (d) rate performance comparison and (e) schematic illustration of non-topotactic reversible reaction in NIB.

Reference:

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