High efficiency immobilization of selenium on sulfur-doped porous carbon for Li–Se and Na-Se batteries

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Selenium is an attractive cathode material for energy storage due to its high theoretical capacity (675 mA g $^{-1}$) and high material density (4.2 g cm^{-3}). However, practical application of selenium is hampered by the shuttle effect of polyselenides (Li_2Se_x, x= 3-8) and volume expansion. To address the above problems, we encapsulating selenium into a sulfur-doped (S-doped) macro/meso/micro-pores carbon (SDPC) framework with high specific surface area, which not only can efficiency confined selenium to ease the shuttle effect, but also relieve volume expansion of selenium to polyselenides, and presents high reversible capacity in both Li-ion and Na–ion batteries. In lithium-ion batteries, the Se/SDPC cathode delivers a reversible capacity of 400 mAh g $^{-1}$ with 70% retention over 1600 cycles at a current density of 0.5 C (1 C = 675 mA g $^{-1}$). While in Na-ion batteries, it provides initial capacity of 569.5 mAh g^{-1} and retains 302 mAh g^{-1} after 400 cycles. Moreover, the rate capability is also superb, achieving 260 mA h g^{-1} in Li-ion batteries and 224 mA h g^{-1} in Na-ion batteries at the current density of 20 C (13.5 A g^{-1}). The both high capacity and excellent rate performance, making Se/SDPC a promising cathode material for lithium-ion and Na–ion batteries.

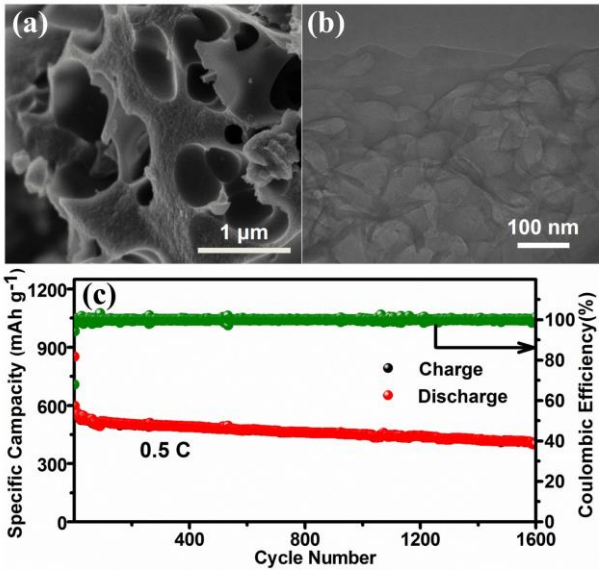

Figure. (a) SEM image of the Se/SDPC composite; (b) TEM image of the Se/SDPC composite; (c) Electrochemical performance of Se/SDPC at a current of 0.5C.