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MoS2 decorated lignin-derived hierarchical mesoporous carbon hybrid nanospheres with exceptional Li-ion battery cycle stability

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PURPOSE OF THE ABSTRACT

Lignin is the most abundant and important macromolecule in organic matter and its yield is second only to cellulose. Lignin is abundant in source, low in price, and has a large number of active groups such as methoxy group and carboxyl group, so it has great utilization value. We developed a feasible self-assembly and carbonization method to prepare lignin-derived porous carbon nanosphere (PCN) and its efficient embedment of MoS2 without any additives. The obtained hybrid nanocomposite provides a possible route to develop high performance Li-ion battery from natural biomass or organizational structures.

Lignosulphonate, isopropanol, sodium molybdate hexahydrate, thiourea were purchased from Aladdin Reagents. Porous carbon Nanosphere (PCN) was prepared using a combined carbonization/activation method and a typical process was shown as below. First, 0.5 g lignosulphonate was dissolved into 10 mL deionized water and then the solution was slowly dripped into 100 mL isopropyl alcohol. The product was separated by centrifugation and was dried at 60 °C for 24 h to obtain LPN. Porous carbon nanosphere (PCN) was obtained by carbonization of LPN at 800 oC for 2h. Secondly, PCN, thiourea, Sodium molybdate hexahydrate were added into 60 mL isopropanol, then the mixture was transferred into a high pressure reactor and the reaction took place at high temperatures and pressures. The resulting product was heated to 800 oC in a nitrogen atmosphere and carbonized for 2 h to obtain MoS2@PCN.[1,2]

Herein the characterizations were investigated by FIIR, DLS, BET, XPS, SEM, TEM etc. The electrochemical performance was investigated by CV and charge and discharge test.

Fig.1a is SEM of MoS2@PCN; we can see that the sheet-like MoS2 is attached to the surface of carbonized LPN. The diameters of the microspheres are calculated in a range of 200 to 300 nm. Figs.1b and c show the TEM of the MoS2@PCN. Large amount of pores can be observed in the carbonized LPN, which greatly increases the specific surface area of the carbon spheres and facilitates the transport of ions. And the lamellar distance between the MoS2 layers is 0.62 nm, which is almost the same as the general MoS2 layer spacing. Fig.1d shows the N2 absorption-desorption isotherms and pore size distribution curves (inner plot) of MoS2@PCN, and the BET surface area of PCN@MoS2 462.8 m2/g.Fig.1e shows the cycling performance of three materials at low current charge and discharge conditions. The theoretical specific capacity of graphite is 355 mAh/g and the specific capacity of PCN used in this work is about 300 mAh/g. It shows the typical characteristics of carbon materials (good cycle stability). In the first few cycles the specific capacity of MoS2 is high, but after several cycling it falls rapidly. In contrast, MoS2@PCN has a stable cycling performance while the specific capacity is 519 mAh/g after 50 cycles.

Briefly, we developed a feasible self-assembly and carbonization method to prepare lignin-derived porous carbon nanosphere (PCN) and its efficient embedment of MoS2 without any additives and the specific capacity of MoS2@PCN is 519 mAh/g after 50 cycles, shows good electrochemical performance.

FIGURES

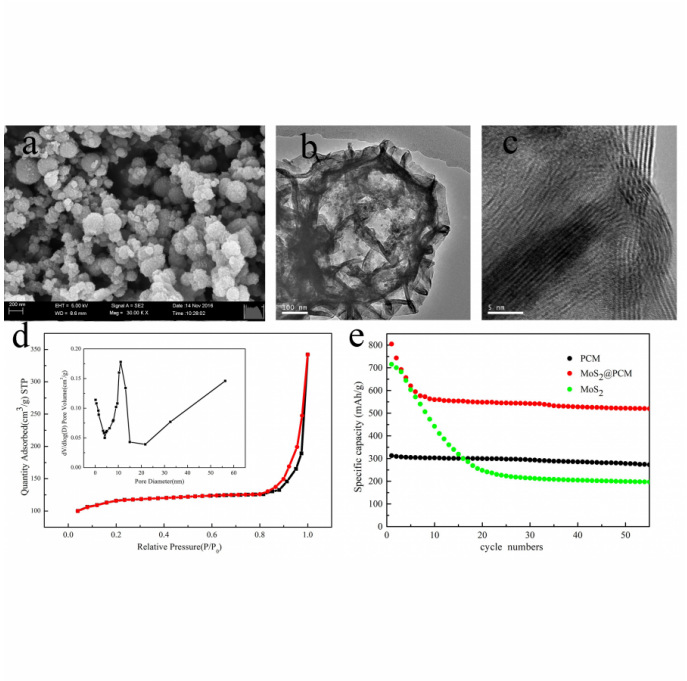

FIGURE 1

Fig.1

(a) SEM of MoS2@PCN, (b,c)TEM of MoS2@PCN, (d) BET resuit of MoS2@PCN (e)Comparative cycling performance at a current density of 0.1 A/g of PCN, MoS2 and MoS2@PCN

FIGURE 2

KEYWORDS

lignin | MoS2 | Porous carbon nanosphere

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