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# PREPARATION 3D STRUCTURAL CARBON PAPER/TIN OXIDE@CARBON AS FREESTANDING ANODE FOR HIGH PERFORMANCE LITHIUM-ION BATTERIES

**Kumari Renu**
Rajajipuram, Hardoai Road, Lucknow-226011

## ABSTRACT

Present review article paper, in recent years, freestanding electrode are interesting usage in high performance LIBs, because they can be directly used as electrodes without the tradition process of making slurry, casting and drying. Tin- based compound are potential anode material for high performance LIBs. The core@shell composite of SnO @ carbon (SnO @C) is successfully fabricated on the substrate of carbon paper(CP) through electrodeposition & carbonization based on the precursor of Sn nanoparticles. The produced CP/SnOx@C film has excellent flexibility & mechanical stability to be directly saved as electrode for LIBs. "/" means interface between SnOx and carbon paper, and "@" means SnOx particle is coated by carbon. Carbon shell prevents the detachment & agglomeration of the active particle during lithiation/delithiation process & maintain the stability of the conductive network. After 100th cycles, CP/SnOx electrode device 0.8mAhcm-2, much higher than the capacity 0.3 mAhcm-2 of CP/Sn electrode operated at the current density of 0.1 mAhcm-2. These feature enable the flexible film of CP/SnOx@C to be attractive application in energy storage device.

***Keywords***: *Litthium-ion batteries, $SnO_x$ nanoparticle, Anode materials, Passivation layer*

## I. INTRODUCTION

Lithium ion batteries(LIBs) are energy storage device have draw great attention in the scientific and industrial fields. The commercial graphite is the most widely used as anode material in the LIBs. However, the development of the graphite anode is also limited by its defects in lower specific capacity (360mAhg$^{-1}$) and safety issues [3].extensive research have been focused on designing and synthesizing novel electrode materials [4-6].

As alternative anode material studied in recent years, tin and tin oxides (SnO or SnO2) have drawn tremendous attention for the low voltage plateau versus Li/Li$^+$ and high theoretical capacities of 980mAhg-1(Sn),1260 mAhg$^{-1}$(SnO) and 1480 mAhg$^{-1}$(SnO2) [7-11].

During Li$^+$ insertion/extraction cycles the tin based electron suffer from enormous volume charges about (300%). Due to this process tin particle cracked & pulverized and weakening the contact between active materials and current collector. Accordingly, it is correct fascinating to design the applicable structure to overcome this problem.

In recent year, freestanding electrodes are very interesting usages in high-performance LIBs; Liu etal. reported tin nanodots as freestanding anode [14]. Wang et al. Synthesized electrode of tin nanoparticle embedded in carbon fibers by utilizing electro spinning. The flexible film of tin oxide/ carbon nanofibers given high capacity and very well cyclic performance. Fabricated the tin-based freestanding anode in several minutes by electrodepositing porous tin nanoparticles onto carbon paper (CP) [16]. A stability structure manufactured by electrodeposition can provide void space among tin nanoparticle to give the take place of volume change during the lithium (de.) alloying process. However, the capacity of CP/Sn still need improvement because the pulverization & aggregation of active material particle still weaken the contact between the active material the current collector. EXPERIMENTAL SECTION

## II. SYNTHESIS OF SAMPLE

The carbon paper ( Hongtu carbide CO, LTD, choina) was clearly washed by ethanol and it's cut into size of 1cm * 8cm. The electrolyte solution contained $Na_2SnO_3.4H_2O$ (35gm) and $H_2O_2$ (3ml) were dissolved in 200deionized water .In the electrodeposition process, graphite stick was used as the counter electrode and carbon paper used as the working electrode the parameter of electrodeposition were set at a current of 50 $mAcm^2$ for 3min and the electrolyte was solely stirred at $70^0$ C. After some time cleaned by deionized water, finally get the porous tin film electodeposited on carbon paper (named as CP/Sn) was applicable for the subsequent passivation. To find a thin passivation layer outside tin particle , sample of CP/Sn was kept at $60^0$C for 72 h in air and the synthesis of sample simply language name as CP/Sn@Sn Ox. The copmposite sample of CP/Sn @Ox was submerged in the aqueous solution (1$gmL^{-1}$) of polyvinyl pyrolidone (PVP) for 48h at $40^0$ C PVP solution used as a carbon source was coated on the surface of the tin nanoparticles. And then, the sample under $N_2$ atmosphere was heated at $700^0$C for 3h. Under high temperature treatment, tin element caught the O atom of PVP and manipulated to $SnO_2$ while PVP was carbonized. At the overdue period of carbonization, minor $SnO_2$ was knock down to SnO due to presence of carbon, and finally the 3 dimensional (3D) structure of CP/SnOx@ was clearly fabricated.

## III. STRUCTURAL AND MARPHOLOGICAL CHARACTERIZATION,

Here structural and morphological characterizations are taking from the review article. X-ray results was carried on Rigaku diffractometer 30kV and 30mA (as given article). The patents diffraction were collected at a scan rate of $3^0$ $min^{-1}$ from 10 to $90^0$. The crystal morphology was recorded by scanning electron microscopy (SEM). The sample was transferred by using by special type of scaled box which is connected with the XPS equipment. To find the binding energies were calibrated according to the C is peak at 250.5eV (as given areticle ).

## IV. ELECTROCHEMICAL TEST

The CP/SnOx@C sample size of 1cm ×1cm was used directly as an electrode in an electrochemical cell to evaluate its performance. It is characterized by using CR2016-type coin cells. The cells was collected within a glove box filled with Ar atmosphere. The electrolyte was 1M $LiPF_6$ in EC:DMC=1:1, and the separator is celgrard 2500, and the counter electrode is lithium metal. The process of charge/discharge system were implement on LAND CT 2001 (wuhan,china) in voltage range of 0.001-3.0V at ambient temperature of $25^0$C (as given article). For the charge/discharge tests applied the current density and based on the area of the sample the collected specific capacity waS calculated. When tested as anode for LIBs the CP substrate is inactive because of it has negligible capacity. By using an electrochemical work station (Prinston, PARSTAT2273) range from the frequency $10^{-2}$to $10^5$ Hz electrochemical impedance spectroscope were recorded. The cell were at the third discharge and the fourth charge state before EIS measurement, respectively.

## V. RESULT AND APPROACHES

The simplified synthesis route for CP/SnOx@C sample and the comparison sample (comp S) shown in fig :1 naturally tin particle are electrodeposited onto a carbon paper for grow passivation film outside tin particle the CP/Sn of sample is heated under the air atmosphere. After the CP/SnOx sample is deep in PVP solution, due to the attractive effect and thermal motion of PVP molecule PVP chain slice wrap up tin oxide particle when the composite of CP/SnO@SnOx@PVP in $N_2$ Atmosphere and heated at high temperature, tin element catch the O atom from PVP and it's convert to $SnO_2$ at the initial thermal stage .Finally the coated PVP is carbonized and converts to carbon shell onto the $SnO_2$ nanoparticle. In the next duration of carbonization, the presence of carbon reduces some of $SnO_2$ and a joint as SnOx. If CP/Sn sample film is directly enwrapped by PVP without passivation, then the tin particles melt out of shape without the passivation shell when the heating temperature is above to the melting point of medallic tin ($231^0$C). The milled tin split above and mixed with the PVP chain systems due to the attractive

efforts from O atoms of PVP chains. After characterization, appear powdering tin particles on the substrate of carbon paper.

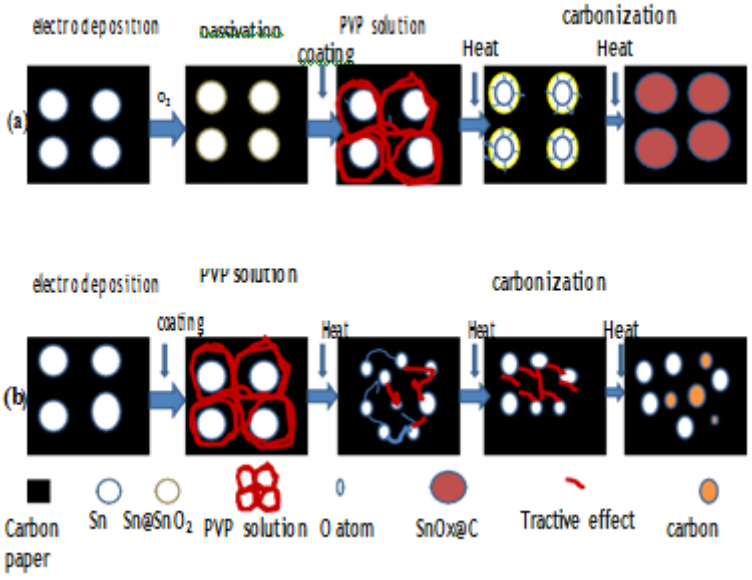


**Fig1.Schematicsynthesisroute forCP/SnOx@Cfilm(a) andCompS(b)**

## VI. CONCLUSION

In conclusion, onto the substrate of carbon paper a core@shell shsape of SnOx@C is successfully fabricated and act as freestanding electrode directly assembled in LIBs. The important way of the synthesis is the passivation shell outside tin particle, which protect the spherical shape of tin particle during the carbonization process of carbon precursor. In enhancing electrochemical properties by the several advantage of CP/ Sn Ox@C. During the charge/discharge cycles prevent the aggregation of active particle by the existence of carbon –shell. The 3D structure designed for tin-based anode is promising to be extended to other anode materials that suffer from volume changing & separation from current collector. The composite material exhibited a high capacity, long cycle life, excellent cycle stability and a fast charge/discharge rate.

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