Effect of growth temperature on the morphology and bonded states of SnO_2 nanobaskets

Abstract

The nanobaskets of SnO_2 were grown on in-house fabricated anodized aluminum oxide pores of 80 nm diameter using plasma enhanced chemical vapor deposition at an RF power of 60 W. Hydrated stannic chloride was used as a precursor and O_2 (20 sccm) as a reactant gas. The deposition was carried out from 350 to 500 'C at a pressure 0.2 Torr for I5 min each. Deposition at 450 ‘C results in highly crystalline film with basket like (nanosized) structure. Further increase in the growth temperature (500 "C) results in the deterioration of the basket like structure and collapse of the alumina pores.The grown film is of tetragonal rutile structure grown along the [l l 0] direction. The change in the film composition and bonded states with growth temperature was evident by the changes in the photoelectron peak intensities of the various constituents. ln case of the film grown at 450 c, Sn $3d_{5/2}$ is found built up of sn_{4+} and o-sn_{4+} and the peaks corresponding to sn_{2+} and O-Sn_{2+} were not detected.

I. Introduction

Tin oxide, a suitable candidate that finds wide application in the field of sensors, opacifiers, functional ceramics, solar cells, etc. Its low cost, chemical stability, useful electrical properties made it a favorable industrial compound. Nanostructured materials are of particular interest which have boosted the performance and attracted the interest of researchers and industrialist. The increased surface area has tremendously changed the consumption and materials usage. Nanostructured electrodes have shown better capabilities than conventional electrodes of the same material. In case of lithium-ion based batteries, the increased surface area can reduce the ion-diffuse distance increasing the effective current density during discharge in comparison with conventional electrodes. At the same time, the internal damages caused by volume discharge via expansion/contraction (insertion/removal of lithium-ion) can be limited by the nanostructure itself

[L_2]. Many methods to produce such nanomaterials of tin oxide are reported widely. Amongst these, sol-gel template synthesis, Chemical precipitation, gas condensation, surfactant templating are some of the recently developed techniques [3-8]. The patteming technology has equally improved in order to accommodate such nanomaterials. The anodic aluminum oxide (AAO), a simple fabrication process, presents an attractive template for the fabrication of highly ordered array of nanopores [8—l l]. wherein the size of nanopores (5—l00 nm) can be controlled by carefully adjusting electrochemical parameters. There is a great demand for the use of such highly ordered nanohole assembly for fabricating the well—ordercd thin film array. novel nanostructures. high density storage media. functional nanomaterials exhibiting quantum size effect. etc. The nanopores can act as template for fabrication of novel nanostructured material with control over the base structure and or sizes. ln this work. the nanostructures of SnO_2 were grown using RF-plasma (60 W) chemical vapor deposition in the in-house