CHAPTER 1

Introduction

Tin(IV) oxide (SnO_2) based powders and films find numerous applications (Beshkov et al, 1995; Labeau et al, 1993; Chopra et al, 1983). These include:

1. Solar Cells

Solar cells make use of conducting films of tin oxide (TO) as transparent electrodes and also as p-insulator-n heterojunctions. TO possesses a refractive index that falls in the 1.8 - 2.0 μm wavelength range; this property renders it useful as a material for anti-reflection coatings in silicon-based solar cells (DeSenza et al, 1997; Harrison, 1992; Lien et al, 1988). The compound, in the form of indium tin oxide (ITO), finds similar industrial uses.

2. Heat mirrors

Unlike a conventional tungsten lamp, which emits only 10% visible radiation but 90% heat through a glass envelope, a coating of TO permits only the visible radiation to be transmitted, the heat that has been generated being reflected back. Heat mirror coatings are able to reduce heat radiation in the area illuminated by the lamp (Chopra et al, 1983).

3. Opto-electronic devices

Opto-electronic devices that make use of thin films of TO as well as ITO include electrochromic display devices, light emitting diodes and liquid crystal display devices. Transparent conducting TO films are also used in high-sensitivity photodetectors, ferroelectric photoconductors, and image storage and display devices. The high transmittance coupled with a low refractive index of such films results in a quantum efficiency of 60 - 80% in the 0.4 - 1.0 μm wavelength range when these are used as transparent gates in charge-injection and charge-coupled devices. More importantly, both TO and ITO films are resistant to laser damage (Chopra et al, 1983), a property that offers potential for use in Pockells cells, i.e., electro-optic shutters in high-energy solid-state laser systems.

4. Thin film resistors

TO is a material having a low temperature coefficient of resistivity, a property that allows for its use as thin film resistors. It is thermally stable, the stability dependent on dopant concentration and film thickness (Lien et al, 1988).

5. Gas sensors

Research on pollution control devices for the detection of hazardous gases has led to the development of gas sensing devices based on thin TO films (Harrison, 1992; Lien et al, 1988; Devi, 1998), which detect carbon dioxide, hydrogen, hydrogen sulphide and a range of hydrocarbons.

The use of TO films as a smoke sensor has been reported. The device consists of TO film sandwiched between a metal electrode and an insulating substrate; the change in conductivity occurs from the direct transfer of electrons from the adsorbed gas to the TO (Chopra et al, 1983; Choi et al, 1997; Miyata et al, 1997), i.e., a change in conductivity is indicative of smoke in the region near to the detector.

6. Applications in wear resistance

TO films are vapour-deposited onto glass containers to enable such containers to withstand wear during manufacture or during filling.

7. Industrial TO-based catalysts

TO is one of the two components of a number of binary metal-oxide systems that are extensively used as catalysts, particularly in the synthesis of petrochemicals. (Chopra et al, 1983; Harrison, 1992].

The ability of TO to oxidise carbon monoxide has also led to air purification applications, for example, in submarines and as safety masks.

Materials based on tin have attracted many researchers from advanced materials laboratories because of the high capacity that can be obtained when they are used as negative electrodes in lithium batteries.

In 1994, Fujifilm Celltech (Brousse et al, 1998; Weifeng et al, 1998) has announced the use of a new TO-based anode (Stalion) in their batteries.

Despite the wide applications of TO, there has been only scanty reports on a convenient preparation of this compound in a pure form. Most published methods require the use of precipitating reagents, and in a number of reactions, relatively high temperatures are needed. A recent report (Wu et al, 1996) has claimed that this compound can be prepared by a "soft chemistry" method, without any precipitating reagent. The aim of this work is to prepare tin oxide by soft chemistry method and using the "home-made" tin oxide to prepare vanadium tin oxide and lithium tin oxide.

The properties of these materials will be probed using a number of methods, and these properties compared with those of the mixed oxide prepared using tin monoxide as one of the starting reagents instead of tin dioxide.