TRANSPARENT CONDUCTIVE SN BASED

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Abstract

Transparent conductive Sn based electrodes are the most relevant solutions to many problems in physics and electronics. This article discusses the use, production methods, resistance, ratio, manufacture and application of transparent conductive Sn based electrodes

Keywords: electrodes, devices, optoelectronics, automation, photoresistive, photopotentiometer, vacuum, pyrolysis, reactive, film, cadmium.

INTRODUCTION

Transparent electrodes are necessary in many modern photovoltaic devices used in optoelectronic devices, measuring circuits, circuits for automatic registration and control of radiation: In particular, in layered photoresistive structures and can be used in the manufacture of ohmic electrodes and current-carrying contacts for photoresistors, photopotentiometers, optocouplers, etc. [1]. All materials for transparent electrodes (with the exception of thin sawn metal films made of gold, silver, etc.) are semiconductor films of oxides.

RESEARCH MATERIALS AND METHODOLOGY

Thin films of tin oxides or indium - ITO (indium and tin oxides) have low resistance and high transparency [2].

Transparent conductive thin films are produced by four methods.

1. Vacuum evaporation. Vacuum evaporation is performed at a pressure of 10-3-10-5 mmHg and the substrate temperature is 3500-4000C, however, the evaporation conditions of metal (Sn, In) and powder (SnO2, In2O2) are somewhat different.

The resistance of SnO2 films is somewhat high, according to this method, at a relatively low temperature (~4000C), it is possible to obtain an In2O2 film having a resistance of 2 • 10-4 ohms • cm and a transparency of 80-90% in the visible spectral region [3,4,5].

2. Pyrolysis of crystalline tin. Pyrolysis of SnCl2•2H2O allows to obtain layers according to the following scheme. First, the substrate is washed in a sulfuric acid solution for 1 minute, then heated with running water, rinsed with distilled water, degreased with alcohol and dried by heating with warm air. Such washing ensures that the glass is cleaned from various surface contaminants, which negatively affects the adhesion strength of the layer to the glass.

The cleaned substrate is heated in the furnace to a temperature of 380-5500C. At the same time, another furnace with an elevated temperature of 30-400C is heated. The resulting vapors, mixing with the supplied air, rise and enter the first furnace through the gateway or pipeline, where it is deposited on the substrate in the form of a thin layer.

The method of pyrolysis of the SnCl2•2H2O material allows to obtain layers of SnO2 with a resistance from several ohms to hundreds of thousands of ohms by adding an impurity in the form of antimony trichloride SbCl3 to the source material.

3. Reactive cathode sputtering of tin metal. The essence of this method, which is one of the progressive methods for obtaining SnO2 layers, is that Sn is sprayed at a substrate temperature of 4000C in an atmosphere of oxygen mixed with an inert gas (for example, an argon -oxygen mixture) at a pressure of 10-3-10-2, and as a result, films of sprayed tin oxides of the type SnO2 and SOX are formed on the substrate, where x<2, this method makes it possible to obtain transparent conductive films with a resistance of 2 • 10-4 ohms • cm and a transparency of 80-90% in the visible wavelength range.

4. Hydrolysis of solutions of chlorine tin. This method has become the most widespread. It allows you to obtain electrically conductive semiconductor layers of SnO2 by processing a substrate heated to a temperature of 500-5500C with SnCl2•5H2O solutions.

The process of layer formation takes place within a few seconds. The resulting layer mainly contains tin dioxide SnO2, in the structure of which there are tin monoxide SnO2 and a small amount of metallic tin Sn. Chemical pure without these impurities, SnO2 is a dielectric. The presence of impurities of Sn and SnO2 causes a violation of the structure of the crystal of SnO2 and leads to the appearance of electrical conductivity of the layer.

By the method of vacuum evaporation and pyrolysis of crystalline tin, we have obtained improved translucent contacts with very high quality. The transparency and resistances of the obtained samples were investigated [6,7,8].

The goal is achieved by using cadmium or tin as a metal and, before cathodic spraying, a layer of tin or cadmium 0.02-0.03 microns thick is thermally evaporated onto cadmium or tin plates, respectively, and for a cadmium plate with a tin layer applied, cathodic spraying is carried out in a gas mixture containing 60-65 vol% argon and 35-40 vol% oxygen, and for tin plates with a cadmium layer applied, cathode sputtering is carried out in a gas mixture containing 15-20 vol% argon and 80-85 vol% oxygen. The substrate temperature is 4000C. These modes were identified by us for deposition of ITO layers with optimal optoelectric properties on glass substrates.

RESEARCH RESULTS AND DISCUSSION

In SnO2 (CdO) films with the presence of an insignificant amount of cadmium (tin) produced by cathode sputtering without subsequent annealing, the electrical conductivity and transparency of the samples are significantly improved.

At the same time, with an increase in the thickness of the cadmium or tin layer (d□ 0.03 microns), the transparency of the samples deteriorates, and with a decrease (d□0.02 microns), the electrical conductivity [9,10,11].

A thin layer of tin with a thickness of 0.02 microns is applied to a cadmium plate with a size of 1□0.3□0.1 cm by thermal evaporation in a vacuum of the order of-10-4 mmHg. art. and strengthened as a cathode in a cathode sputtering installation, and the design of the cathode holder circulates liquid cooling in the inner cavity to maintain the cathode temperature within certain limits. The anode consists of an aluminum block with an inserted heater plate on which 2-8 substrates are placed simultaneously. As substrates, glass plates with a size of 2.7□10□ 0.3 cm are taken, which are pretreated with nitric acid, then boiled in distilled water for 15-20 minutes. and dries, wipe with alcohol. In the manufacture of conductive transparent films , the chamber is filled with a mixture of inert gas and oxygen in the ratio:

a) for cadmium plates with a layer of tin deposited, cathode sputtering is carried out in a gas mixture containing 60-65 vol. % argon and 35-40 vol% oxygen.

B) for tin plates with a layer of cadmium deposited, cathode sputtering is carried out in a gas mixture containing 15-20 vol. % argon and 80-85 vol .% oxygen.

At a current density of 1.45-1.5 mA / cm2 (E= 2 kV / cm) in a vacuum of the order of 10-2 mmHg, spraying is carried out at a speed of 90-100A / min, to form a transparent conductive film of cadmium oxide with a thickness of 0.1-0.15 microns on a glass substrate, the transparency of the film in the region of □= 700-720 nm is 80% and the resistance is 90 ohms.

Transparent contact can be used in the manufacture of complex semiconductor devices.

This method has the following positive aspects:

-increasing the adhesive properties of films,

-ensuring the chemical stability of films,

-increasing the reliability of semiconductor devices.

The present method of manufacturing transparent conductive films from cadmium oxide or tin is used to manufacture electrodes for photodetectors with good adhesion of films to the substrate, chemical stability and without additional annealing.

CONCLUSION

For the manufacture of transparent conductive films based on metal oxides on dielectric substrates, including cathodic spraying of metal oxide plates in a gas mixture of argon and oxygen, characterized in that, in order to increase the electrical conductivity and transparency of the films, cadmium or tin is used as a metal and a layer of tin is applied to cadmium or tin plates by thermal evaporation before cathodic spraying or cadmium 0.02-0.03 microns thick.

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