International Journal of Applied Research 2015; 1(13): 739-741

International Journal of Applied Research

ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2015; 1(13): 739-741
www.allresearchjournal.com
Received: 26-10-2015
Accepted: 29-11-2015

Dinesh Singh
Associate Professor & Head
Deptt. Of Physics, Pt. N R S
Govt. College Rohtak

Correspondence
Dinesh Singh
Associate Professor & Head
Deptt. Of Physics, Pt. N R S
Govt. College Rohtak

A study on gas sensor devices and transparent conducting oxide films

Dinesh Singh

Abstract

Transparent conducting oxide (TCO) thin films of In_2O_3, SnO_2, ZnO, and their mixtures have been extensively used in optoelectronic applications such as transparent electrodes in touch panels, flat panel displays (FPDs), and other future devices. The first chapter provides an introduction to the basic physics of TCO films and surveys the various topics and challenges in this field. It includes a description of the TCO materials used in some of the organic light emissive devices (OLEDs) that have been studied extensively to date, the performance of various OLEDs, and a brief outlook.

Keywords: gas sensor devices, transparent, films

Introduction

TCOs are very useful materials to transparent optoelectronics because they have unique features of optical properties in the visible light region such as the transparency over ~85% and optical band gap greater than 3 eV and controllable electrical conductivity such as carrier concentrations of at least 1020 cm-3 and resistivity of about 10-4 ohm·cm. (Kim *et al.*, 2011)

Nowithstanding their extraordinarily wide controllable conductivity range including that of semiconductor behavior, their applications are limited to transparent electrodes. It seems to us that the origin of this limited application is due to a lack of p-type conducting transparent oxide materials. TCO materials are naturally n-type degenerate semiconductors and the lack of a high quality p-type TCO always has been the main obstacle in front of the fabrication of a fully transparent complementary metal-oxide semiconductor(CMOS)-like devices. Although n-type TCO such as ZnO, SnO_2 and ITO are key components in a variety of technologies, p-type TCO are an emerging area with little work previous to four years ago. However, realization of good TCO could significantly impact a new generation of transparent electrical contacts for p-type semiconductors and organic optoelectronic materials and in conjunction with n-type TCOs could lead to a next generation of transparent electronics.

Characterization of Tco Films

The purpose of the 4-point probe is to measure the resistivity of any semiconductor material. It can measure either bulk or thin film specimen, each of which consists of a different expression. The derivation will be shown in this tutorial. In a sheet resistance measurement, several resistances need to be considered.

The probe has a probe resistance *R*p. It can be determined by shorting two probes and measuring their resistances. At the interface between the probe tip and the semiconductor, there is a probe contact resistance, *R*cp. When the current flows from the small tip into the semiconductor and spreads out in the semiconductor, there will be a spreading resistance, *R*sp. Finally the semiconductor itself has a sheet resistance *R*s. The equivalent circuit for the measurement of semiconductor sheet resistance by using the four-point probe.

Two probes carry the current and the other two probes sense the voltage. Each probe has a probe resistance *R*p, a probe contact resistance *R*cp and a spreading resistance *R*sp associated with it. However, these parasitic resistances can be neglected for the two voltage probes because the voltage is measured with a high impedance voltmeter, which draws very little current. Thus, the voltage drops across these parasitic resistances are insignificantly small.

The voltage reading from the voltmeter is approximately equal to the voltage drop across the semiconductor sheet resistance.

Optical Properties

UV-VIS refers to absorption spectroscopy or reflectance spectroscopy in the ultravioletvisible spectral region. This means it uses light in the visible and adjacent (near-UV and near-infrared (NIR)) ranges. A sample in a cuvette is exposed to light energy between 190 nm and 1000 nm. Spectrophotometry investigates the absorption of the different substances between the wavelength limits 190 nm and 780 nm (visible spectroscopy is restricted to the wavelength range of electromagnetic radiation detectable by the human eye, that is above ~360 nm; ultraviolet spectroscopy is used for shorter wavelengths).

In this wavelength range the absorption of the electromagnetic radiation is caused by the excitation (i.e. transition to a higher energy level) of the bonding and non-bonding electrons of the ions or molecules. A graph of absorbance against wavelength gives the sample's absorption spectrum. Modern spectrophotometers draw this automatically. The measured spectrum is continuous, due to the fact that the different vibration and rotation states of the molecules make the absorption band wider. Certain parts of an organic molecule will absorbance some of this energy to create peaks on a spectrum for quantitative (primarily) and qualitative Analysis. The original UV-Vis specs were made as *DOUBLE-BEAM* units to correct for noise, drift and other Instabilities.

Over 20 years ago, the well-known leaders in the analytical instrument markets; Beckman & Perkin-Elmer; began to focus on a line of "Stable-Beam" SINGLEBEAM Instruments. Spectrophotometry is used for both qualitative and quantitative investigations of samples. The wavelength at the maximum of the absorption band will give information about the structure of the molecule or ion and the extent of the absorption is proportional with the amount of the species absorbing the light.

The SEM has many applications across a multitude of industry sectors. It can produce extremely high magnification images (up to 200000 times) at high resolution up to 2 nm combined with the ability to generate localised chemical information (EDX). This means the SEM/EDX instrument is a powerful and flexible tool for solving a wide range of product and processing problems for a diverse range of metals and materials.

Research Study

A finely focused electron beam scanned across the surface of the sample generates secondary electrons, backscattered electrons, and characteristic X-rays. These signals are collected by detectors to form images of the sample displayed on a cathode ray tube screen. Features seen in the SEM image may then be immediately analyzed for elemental composition using EDS or WDS. Secondary electron imaging shows the topography of surface features a few nm across. Films and stains as thin as 20 nm produce adequate-contrast images.

Materials are viewed at useful magnifications up to 100,000 times without the need for extensive sample preparation and without damaging the sample. Even higher magnifications and resolution are routinely obtained by our Field Emission SEM.

Backscattered electron imaging shows the spatial distribution of elements or compounds within the top micron of the sample. Features as small as 10 nm are resolved and composition variations of as little as 0.2% determined. Data output is generated in real time on the CRT monitor. Images and spectra can be printed here, recorded on CD-ROM and/or emailed for insertion into your own reports.

Diffraction effects are observed when electromagnetic radiation impinges on periodic structures with geometrical variations on the length scale of the wavelength of the radiation. The inter-atomic distances in crystals and molecules amount to 0.15–0.4 nm which correspond in the electromagnetic spectrum with the wavelength of x-rays having photon energies between 3 and 8 keV. Accordingly, phenomena like constructive and destructive interference should become observable when crystalline and molecular structures are exposed to x-rays. Firstly, the geometrical constraints that have to be obeyed for x-ray interference to be observed are introduced. Secondly, the results are exemplified by introducing the $\theta/2\theta$ scan, which is a major x-ray scattering technique in thin-film analysis. Thirdly, the $\theta/2\theta$ diffraction pattern is used to outline the factors that determine the intensity of x-ray ref lections. We will thereby rely on numerous analogies to classical optics and frequently use will be made of the fact that the scattering of radiation has to proceed coherently, i.e. the phase information has to be sustained for an interference to be observed.

Significance of the Study

The most commonly used polymeric whole conductor is PEDOT: PSS, sold by H.C, Starch as Baytron®P. And it acts as the anode and normally deposited from an aqueous dispersion. This polymer is water soluble, and hence can be used as a transparent anode PEDOT: PSS belongs to the class of semiconducting polythiophenes. High conductivity PEDOT: PSS is considered as the most relevant polymer to replace TCOs and has been successfully introduced in organic solar cells and/or OLEDs as transparent bottom electrode, located directly on the substrate, or as transparent top electrode. In an experiment to prove the principle, Arias *et al.* have shown that a poly(p-phenylenevinylene) (PPV) layer sandwiched between PEDOT:PSS and Al forms a photovoltaic device independent of whether a polymer or a metal is deposited as the final layer. To overcome resistive losses across the anode, the conducting polymer has been deposited by spin-coating or screen printing on an underlying metal grid with gold or silver.

The development of water-soluble transparent conducting-doped polyaniline (PANI), enabled the first fabrication of an "all plastic" polymer light emissive devices (PLEDs). The metallic emeraldine salt form of PANI was prepared by protonation with camphor-sulfonic acid (CSA), yielding a conducting PANI complex soluble in common organic solvents.

Tco For Flexible Oled

In most case, OLEDs have been traditionally fabricated on glass substrate, however, there OLEDs have several disadvantage for certain applications such as portable communication display, because the glass substrate is very fragile, heavy and non-flexible. Flexible OLEDs (FOLEDs) using the plastic substrate are growing attention, because a plastic substrate can be overcome disadvantages of a glass substrate. These devices provide the ability to conform, bend or roll-up display into any shape. (Gu *et al*., 2007) [7] This means that FOLEDs may be laminated onto an automotive windshield, or an aircraft cockpit *et al*.

However, the low thermal stability of a plastic substrate (Tg=80 °C) is difficult the process for making transparent conducting electrode, indium tin oxide (ITO), and TFT. These materials are necessary for the high temperature ≥ 200 oC. Conventional FOLEDs are fabricated the polymer materials. (Gustaffson *et al*., 2003; He & Kanicki, 2000) [10] Y. Zhang and S. R. Forrest were suggested that thermal deposited organic thin films have the general flexibility property by the van der waals force between aromatic atoms-to-atoms.

References

1. Deng ZB, Ding XM, Lee ST. Enhanced Brightness and Efficiency in Organic Electroluminescent Devices using SiO2 Buffer Layers. *Applied Physics Letters*, (December 2008), 2009; 74, 15:2227-2229. ISSN 0003-6951
2. Dingle R, Störmer HL, Gossard AC, Wiegmann W. Electron Mobilities in Modulation-Doped Semiconductor Heterojunction Superlattices. Applied Physics Letters, 2008; 33(7):665-667. ISSN 0003-6951
3. Ghosh CK, Popuri SR, Mahesh TU, Chattopadhyay KK. Preparation of Nanocrystalline CuAlO2 through Sol-Gel Route. Journal of Sol-Gel Science and Technology. 2006, 2009; 52(1):75-81. ISBN 0928-0707
4. Gu G, Bulović V, Burrows PE, Forrest SR. Transparent Organic Light Emitting Devices. Applied Physics Letters, 2006; 68:2606-2608. ISSN 0003-6951
5. Guan HS, Gheng CH, Li WC, Geng DF, Fan ZQ, Chang YC *et al.* Influence of Transparent Anode on Luminescent Performance of Near-Infrared Organic Light-Emitting Diodes. Chemical Research in Chinese Universities, 2009; 25(6):786-789. ISSN 1005-9040
6. Guillen G, Herrero J. Transparent Conductive ITO/Ag/ITO Multilayer Electrodes Deposited by Sputtering at Room Temperature, Optics Communications, 2008, 2009; 282(4):574-578. ISSN 0030-4018
7. Gu G, Burrows PE, Forrest SR, Thompson ME. Vacuum-Deposited, Nonpolymeric Flexible Organic Light-Emitting Devices. Optics Letters, 2007; 22(3):172-174. ISSN 0146-9592
8. Guo ZG, Zhou F, Hao JC, Liu WM. Stable Biomimetic Super-Hydrophobic Engineering Materials. Journal of the American Chemical Society. 2005; 127(45):15670-15671, ISSN 0002-7863
9. Han J, Mantas PQ, Senos AMR. Effect of Al and Mn Doping on the Electrical Conductivity of ZnO. Journal of European Ceramic Society. 2001; 21:10-11:1883-1886. ISSN 0955-2219
10. He T, Kanicki J. High-Efficiency Organic Polymer Light-Emitting Heterostructure Devices on Flexible Plastic Substrates. *Applied Physics Letters,* 2000; 76(6):661-663. ISSN 0003-6951
11. Hirata GA, McKittrick J, Cheeks T, Siqueiros JM, Diaz JA, Contreras O *et al*. Synthesis and Optoelectronic Characterization of Gallium Doped Zinc Oxide Transparent Electrodes. *Thin Solid Films*, 2006; 288; 1-2:29-31. ISSN 0040-6090
12. Honda S, Tsujimoto A, Watamori M, Oura K. Oxygen Content of Indium Tin Oxide Films Fabricated by Reactive Sputtering. Journal of Vacuum Science & Technology A: Vacuum, Surfaces, and Films. 2005; 13(3):1100-1103. ISSN 0734-2101.