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Study of rectifying properties and true Ohmic contact on Sn doped V_2O_5 thin films deposited by spray pyrolysis method

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A B S T R A C T

In this paper, V_2O_5 thin-films were deposited on glass substrates by using the ultrasonically nebulized spray pyrolysis technique. Doping concentration of 1 %, 2 %, and 7 % of Sn, in V_2O_5 thin-films is studied by using metal–semiconductor-metal (MSM) based device structure. X-ray diffractometer (XRD) and field emission scanning electron microscope (FESEM) were used to analyze the surface morphology of the thin films. The XRD spectroscopic analysis shows the crystal size of above-mentioned samples, to be respectively 39 nm, 58 nm, 60 nm and 72 nm. The FESEM images showed the enhancement of crystal size with increase in Sn doping concentration. The optical properties of Sn doping on V_2O_5 thin film were studied by using UV–Vis spectrometer. The UV–Vis spectroscopic analysis shows that the absorption coefficient values decrease with increase in concentration of Sn metal doping in V_2O_5 thin film. The activation energies of all thin-film samples were calculated from Arrhenius plots and were found to be 0.938 eV, 1.101 eV, 1.11 eV and 1.169 eV, respectively, for all the thin-film samples mentioned above. The MSM based structure was fabricated by using a shadow mask and thermal evaporation. Later, the I-V characteristics of all the thin films were obtained by using semiconductor parameter analyzed at a biased voltage between −50 V and + 50 V with a step size of 1 V. Rectification ratio of the V_2O_5 films is significantly enhanced as the doping concentration increases. It was found that the rectification ratio of undoped V_2O_5 thin films increased linearly from 1.018 to 1.059 with an increase in temperature from room temperature to 130 °C. Similar trend was followed for 1 % (from 1.079 to 1.198), 2 % (from 1.081 to 1.224) and 7 % (from 1.095 to 1.311) Sn doped films. These results show the potential application of V_2O_5 thin films in the field of optoelectronics and thin film gas sensors.

Introduction

A thin film is a layer of material ranging from fractions of a nanometer (monolayer) to several micrometers in thickness, which finds its applications in gas sensors, fuel cells, hydrophobic protection, insulators and many other domains [1–4]. For these applications to be used effectively, it is necessary to study the thin films' properties (such as their electrical, mechanical, and optical) change over time in order to forecast their stability [5,6]. Gas sensors are in high demand because they can be used in a variety of applications, including the home, health care, and environmental industries [7–10]. When creating a good gas sensor, it is important to take into account material properties including crystallinity, thermodynamic steadiness, catalytic capacity, consistency, compatibility with manufacturing methods, and adsorption properties. Nevertheless, most of the materials have few of these characteristics, hardly a handful of those have acceptable detecting capability when all of the above sensor requirements are combined [11–15]. Lesser cost, higher effective alcoholic sensors are in extensive demand in the chemical, food, and biomedical productions, particularly for breath examination and wine quality monitoring [16]. Semiconductor gas

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