Optical and structural properties of WO_3 as a function of the annealing temperature

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Abstract: - This work presents a study of effect of annealing temperature on optical and structural properties of WO_3 that has been deposited by hot-filament metal oxide deposition (HFMOD). X-ray diffraction shows that the as-deposited WO_3 films present mainly monoclinic crystalline phase. The Raman spectrum shows four intense peaks that are typical Raman peaks of crystalline WO_3 (m-phase) that corresponds to the stretching vibrations of the bridging oxygen that enhance and increase their intensity with the annealing temperature. Band gap can be varied from 2.92 to 3.15 eV by annealing WO_3 from 0 to 500 °C. The photoluminescence response of the as-deposited film presents two radiative transitions centered at 2.04 and 2.65 eV that are associated to oxygen vacancies.

Key-Words: - Compound semiconductors; HFMOD; Novel Materials and Technological Advances for electrochromics; semiconductors growth; WO_3 semiconductors; XPS, Raman spectroscopy, X-ray, Transmittance spectroscopy

1 Introduction

Transition metal oxides represent a large family of materials possessing various interesting properties, such as superconductivity, colossal magneto-resistance and piezoelectricity. Among them, tungsten oxide is of intense interest and has been investigated extensively for its distinctive properties. With outstanding electrochromic [1], photochromic [2], gaschromic [3], gas sensor [4], photo-catalyst [5] and photoluminescence properties [6], tungsten oxide has been used to construct `smart-window', anti-glare rear view mirrors for automobiles, non-emissive displays, optical recording devices, solid-state gas sensors, humidity and temperature sensors, biosensors, photonic crystals and so forth. WO_3 thin films can be prepared by various deposition techniques such as thermal evaporation [3,7], spray pyrolysis [8], sputtering [9], pulsed laser ablation [4], sol–gel coating [10] and chemical vapour deposition [11].

The purpose of this work is to characterize the WO_3 layers deposited by hot filament metal oxide deposition (HFMOD) technique, which were annealed wide temperature range. This growth technique has some advantage compared the conventional growth technique, it is easily implemented and it is not expensive. The investigations so far carried out in our laboratory show that the films can be deposited with a good stoichiometric control, with relatively high deposition rates and present good adhesion to both metallic and dielectric substrates. The characterization of the deposited material is carried out by XPS, X-ray, Raman spectroscopy and transmittance.

2 Experimental details

The WO_3 thin films were deposited by hot-Filament Metal Oxide Deposition (HFMOD) technique at atmospheric pressure on corning glass at room temperature; its main characteristics have been reported in the literature [12]. For determining the chemical stoichiometry was used X-ray Photoelectron Spectroscopy (XPS). For the XPS analyses, a hemispherical spectrometer using the unmonochromatized Kα X-ray line of aluminum was employed. To investigate the possible tungsten valence states, the 4f-doublet peak or the 3d-doublet