Structural and optical properties of $CdWO_4$ films synthesized by chemical bath deposition

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INTRODUCTION

Last decades thin $CdWO_4$ films have gained exceptional applications because of their high x-ray absorption coefficient and low radiation damage.

Thin cadmium wolframate films can be used as sensors in a variety of applications such as radiation detectors but also in the processes of photocatalytic degradation of organic compounds.

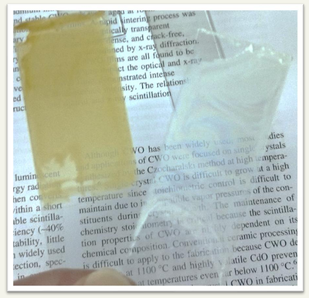

Figure 1. $CdWO_4$ thin films

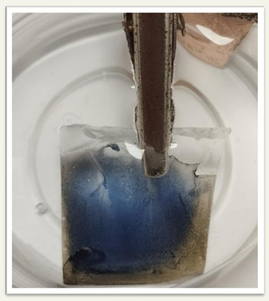

Figure 2. Electrochromism of $CdWO_4$

METHODS AND MATERIALS

Cadmium tungstate thin films were synthesized using an aqueous chemical deposition method. For chemical deposition, stoichiometric amounts of cadmium nitrate and sodium tungstate were used, complexation was performed with hydrogen peroxide, and deposition was performed at a temperature of 100 °C.

After annealing in the air from the room to 600℃ for 1 h, the films were characterized using following techniques: UV-Vis, IR, Raman spectroscopy, SEM and XRD.

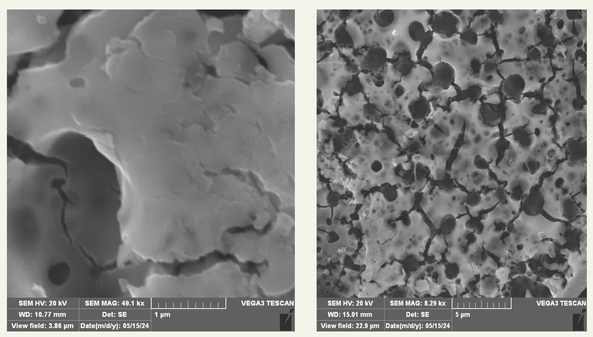

Figure 3. SEM images of $CdWO_4$ thin films after thermal treatment

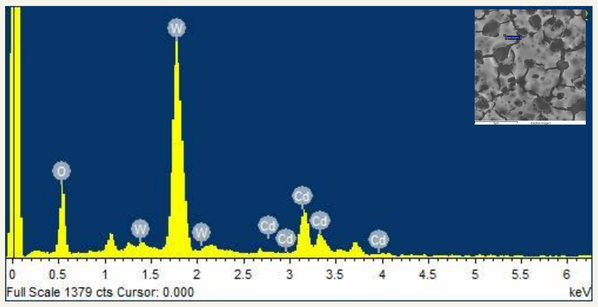

Figure 4. EDX spectra, qualitative elemental composition of the film

RESULTS and DISCUSION

The main challenge in the process of synthesis of tungstate thin films is the deposition rate and the chemical nature of transition metals tungstates which are insoluble in water. In the absence of the complexing agent, the nucleation and the quality of the films are challenging due to the high density of the CdWO4 particles. Hence, complexation agents need to be included in the formulation of the deposition solution.

The EDX spectra confirmed the elemental composition of the film, FTIR results showed $CdWO_4$, with successful detection of v_1 and v_3 modes. Raman spectra confirmed the results from the FTIR analysis.

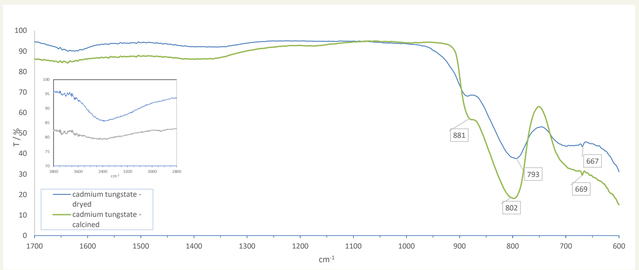

Figure 5. ATR-FTIR spectra of $CdWO_4$ thin films, dried and annealed at 600 °C

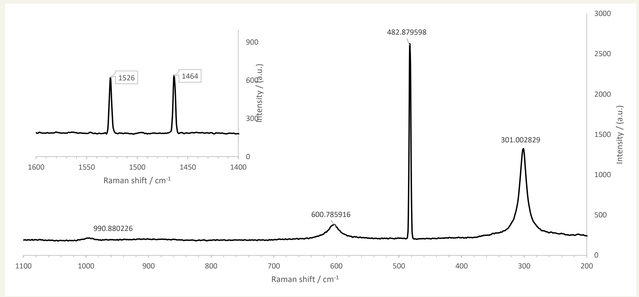

Figure 6. FTIR Raman spectra of $CdWO_4$ film, annealed at 600 °C

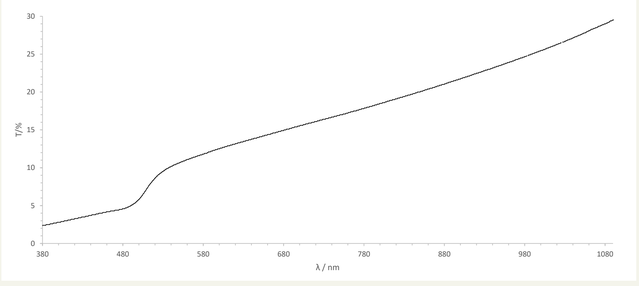

Figure 7. FTIR Raman spectra of $CdWO_4$ film, annealed at 600 °C

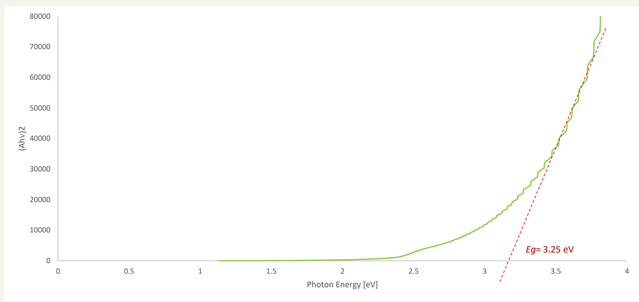

Figure 8. Tauc plot of $CdWO_4$ thin film showing direct transition with energy of 3.25 eV

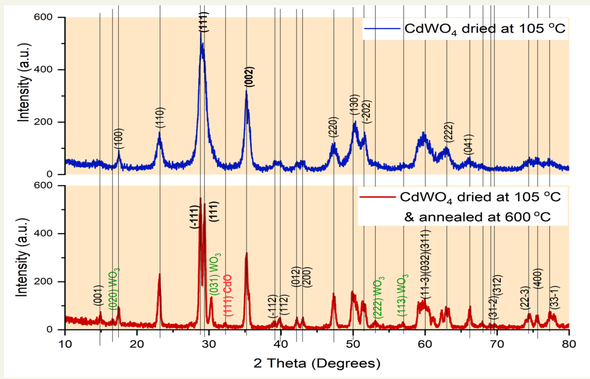

Figure 9. Diffractogram of CdWO4 thin films, dried and annealed at 600 °C

Tauc plot confirmed a direct transition with bandgap energy of 3.25 eV, which correlates with theoretical data.

X-ray diffraction results showed that the films have a monoclinic structure. After deposition and drying, the films have low crystallinity, with thermal treatment the crystallinity of the sample increases significantly.

Change in crystallinity can be observed in the FTIR spectra, with the case of films treated at 600 °C showing more prominent bands and the absence of water due to calcination.

The most interesting application of these films is that they exhibit intrinsic luminescence that can be induced under the action of UV radiation. Thermally treated films have higher fluorescence intensity.

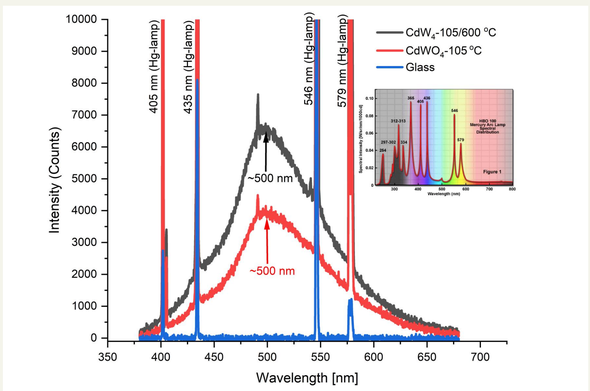

Figure 10. Fluorescence emission spectra, excitation mercury lamp

CONSLUSIONS

- Thin films of cadmium tungstate can be synthesized by an economical method using chemical deposition from an aqueous solution
- Films were fully characterized using: morphological, spectroscopic and structural techniques
- Films show intrinsic luminescence under the action of UV radiation (Mercury Lamp) with a maximum emission wavelength of 500 nm.

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