Effect of the preparation condition on the optical and structural properties for $CoCaO_3$ thin film prepared by chemical bath method

Z B Ibraheem, Saad F. Mahmood ,Hamid A. Salih
New and renewable department, college of science, Mosul University, Iraq
hamid.abdulla@uomosul.edu.iq

Abstract

the Perovskite $CoCaO_3$ thin films was deposition on glass substrates by chemical bath deposition method, the impact of the temperatures at (30, 70, and 85 ^oC) and durations (10, 20, and 30 minutes) on the films' physical characteristics was examined. The energy gap fluctuated between 3.35 eV and 3 eV with the deposition period and between 3.35 eV and 2.4 with the deposition temperature. Crystalline and amorphous phase with a grain sizes about 52.67 nm are included in the films, according to the X-ray spectrum of the films made at 85 °C and duration a 10-minute deposition time.

Keywords: chemical bath deposition CBD, thin films, CaO, semiconductors, perovskite, and nanostructure.

تأثير ظروف التحضير على الخواص البصرية والتركيبية لأغشية CoCaO3 الرقيقة المُحضرة بطريقة الحمام الكيميائي

ز. ب. إبراهيم، سعد ف. محمود، حامد أ. صالح
قسم الهندسة الجديدة والمتجددة، كلية العلوم، جامعة الموصل، العراق
hamid.abdulla@uomosul.edu.iq

الملخص

تم ترسيب أغشية CoCaO3 الرقيقة من البيروفسكايت على ركائز زجاجية بطريقة الحمام الكيميائي، ودُرست تأثيرات درجات الحرارة (30، 70، و85 درجة مئوية) وفترات الترسيب (10، 20، و30 دقيقة) على الخواص الفيزيائية للأغشية. تراوحت فجوة الطاقة بين 3.35 و3 إلكترون فولت مع فترة الترسيب، وبين 3.35 و2.4 إلكترون فولت مع درجة حرارة الترسيب. تتضمن الأغشية طورًا بلوريًا وغير متبلور بأحجام حبيبات تبلغ حوالي 52.67 نانومتر، وفقًا لطيف الأشعة السينية للأغشية المُصنّعة عند درجة حرارة 85 درجة مئوية ومدة ترسيب 10 دقائق.

الكلمات المفتاحية: ترسيب CBD في الحمام الكيميائي، الأغشية الرقيقة، CaO، أشباه الموصلات، البيروفسكايت، والبنية النانوية.

1. Introduction

Perovskites offer a unique class of materials with superior photoluminescence and optical qualities. researching single domain crystals' optical characteristics at different temperatures [1]. Their electrical, magnetic, and optical characteristics—which are dependent to changes in phase, pressure, and temperature—make them extremely significant.[29] Calcium titanite, a naturally occurring mineral, is the source of the name for the broad family of crystalline minerals known as perovskites [2][3][4]. The first synthetic perovskite was produced in 1926 by GOLDSCHIMDT at the University of Oslo (Norway), which led to the use of the term perovskite to describe all structures similar to the compound $CaTiO_3$, represented by the chemical formula ABX3, where A is a cation generally belongs to the rare earth or alkaline earth series, B is a cation with a small ionic diameter that is generally a transition metal or noble metal [X], is an oxygen atom in the case of oxides but may be a halogen or nitrogen in other cases[5] [6][7] . Different methods can be used to prepare thin films of perovskite including chemical bath depositionCBD [8], spray pyrolysis method SPM [9], thermal evaporation [10] and sol gel method [11]. Perovskite has been used in several fields including, solar cell [12], light-emitting diodes [13] and capacitors [14]. In this study the deposition time and temperature effect on the optical and structural properties of $CoCaO_3$ will be studied.

2. Experimental method

Chemical bath deposition CBD was used to prepare thin films of cadmium oxide $CoCaO_3$ glass substrate . Cobalt chloride and calcium chloride were used as a source of cobalt and calcium elements for both CoO and CaO . CoO thin films have been prepared by mixing 0.4g potassium hydroxide KOH dissolved in 50ml distilled water and 0.3gm Cobalt chloride also dissolved in 50ml distilled water, while CaO thin films were prepared by mixing 0.3gm of $CaCl_2$ dissolved in 50ml distilled water and 0.4g 0.4g potassium hydroxide KOH dissolved also in 50ml of distilled water according to the following reactions. Both solutions then mixed and stirred for 1 hr at 85oC. Finally, the glass slides immersed in the later solution at different deposition temperatures and periods.

3. Results and discussion :

Thin films of $CoCaO_3$ have been deposed on glass substrates using chemical bath deposition. Different parameters can be changes during the deposition but the most important parameters are the deposition temperature and deposition periods.

The transmittance and absorbance of the $CoCaO_3$ films prepared with different deposition periods 10 , 20 and 30 minutes were investigated. The transmittance increase with wavelength while the absorbance decrease with wavelength. The transmittance and absorbance varied with deposition time because at first the layer thickness directional proportional to deposition time, then the process is reversed with inversely proportional to deposition time due to the movement of the solution during the deposition process figure (1).

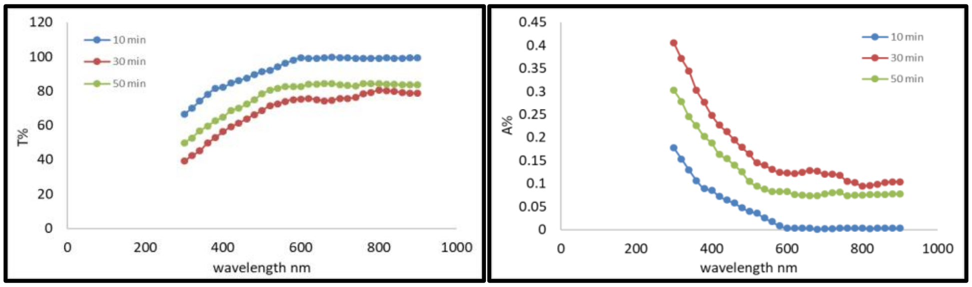

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Figure (1) the transmittance and absorbance of $CoCaO_3$ thin films prepared with different deposition periods.

Also the energy gap was changed with deposition periods, where it was about 3.35eV for the films prepared with 10min deposition period the decrease to 3eV for the films prepared with 20 min and finally increase to 3.2eV for the films prepare with 30 min deposition period figure (2).

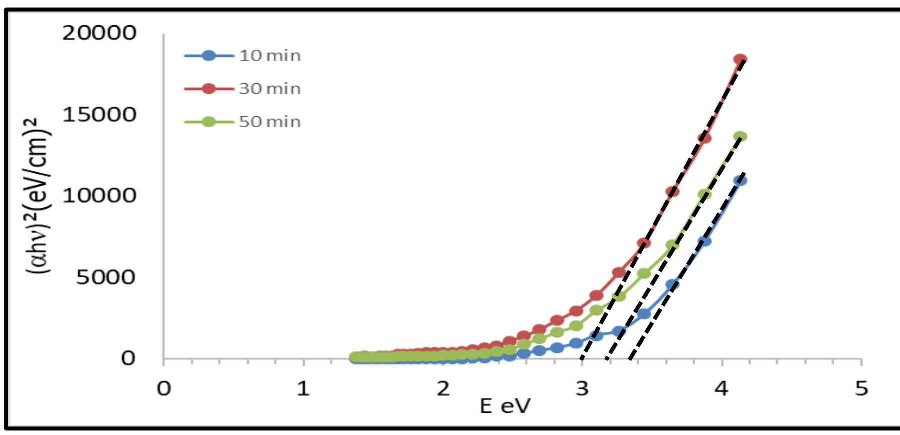

Figure … erent deposition periods.

The films examined using SEM, the images of the films prepared with different deposition periods show a clear change in the films structure figure (3). The grain size at first increase with deposition period then decrease. And this agree with optical properties.

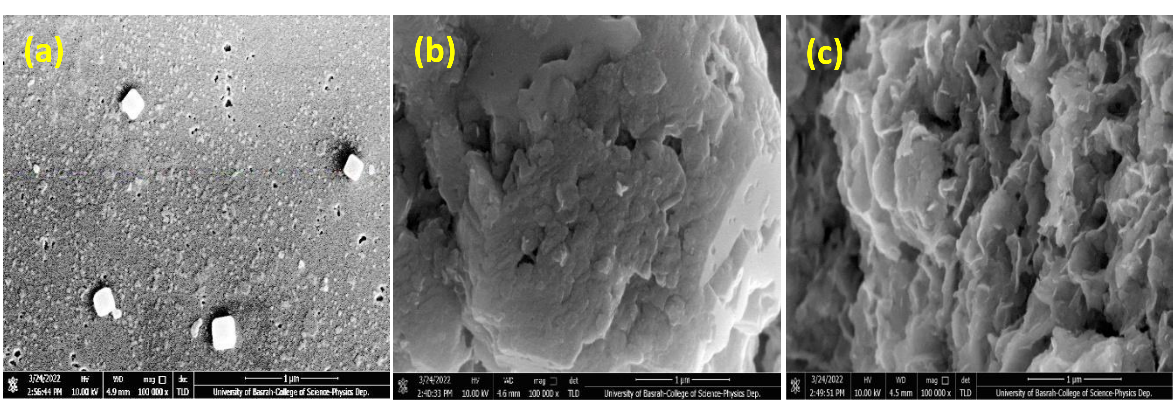

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figure (3)SEM images of the films prepared with different deposition periods (a)10 min,(b)20 min and (c) 30 min

figure (4) show several peaks for the films prepared with 10min deposition period at 85°C. the spectrum show that the film include both phases amorphous and crystalline. The average grain size was about 52.67 nm.

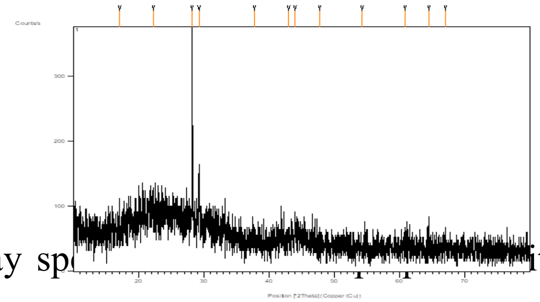

Figure (4) X ray sp… ith 10 min deposition period at 85°C

Table(1) average grain size of the films prepared with 10 min deposition period at 85°C

2-Theta (θ)	FWHM [°2Th.]	D nm	Average grain size nm
17.1451	0.0591	136.1848	52.670
22.258	1.88932	4.285886	
28.1992	0.1593	51.5205	
29.2863	0.11810	69.53153	
37.7544	0.2364	35.5477	
43.0006	0.2363	36.15071	
44.0072	0.2366	36.2775	
47.7090	0.1184	73.55228	
54.2614	1.5743	5.669735	
60.7913	0.1182	77.9834	
64.4706	0.048	195.6528	
67.028	0.144	66.16327	

The transmittance and absorbance of the $CoCaO_3$ films deposited at different deposition substrate temperatures 30,70 and 85°C were investigated. The transmittance increase with wavelength while the absorbance decrease with wavelength. The transmittance and absorbance varied with deposition temperature

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because of the adhesion increase with temperature which in turn increase the films thickness figure (5).

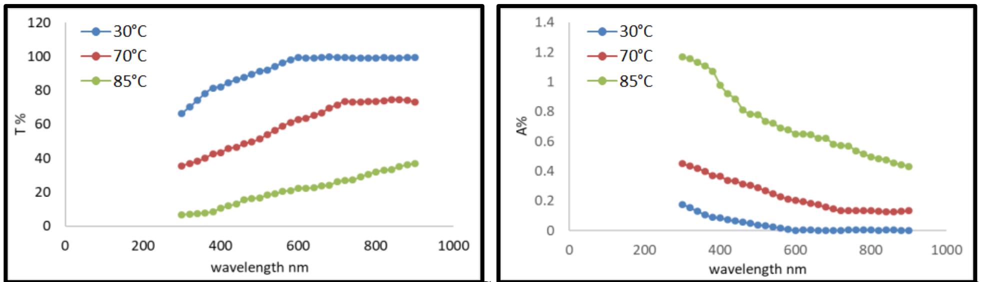

Figure (5) the transmittance and absorbance of $CoCaO_3$ thin films deposited at different deposition temperatures .

The energy gap also varying with the deposition periods, where the it was about 3.35eV for the films prepared at 85°C then decrease to 2.6eV for the films prepared at 70°C and finally decrease to 2.4eV for the films prepare at 30°C figure (6).

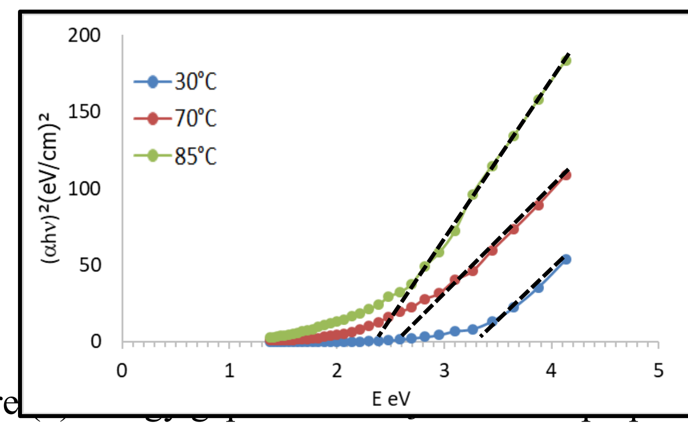

Figure ... d at different deposition temperatures .

The SEM images of the films prepared with different deposition temperatures show a clear change in the films structure figure (7). The grain size at first increase with deposition temperatures due to the grow and aggregation process .

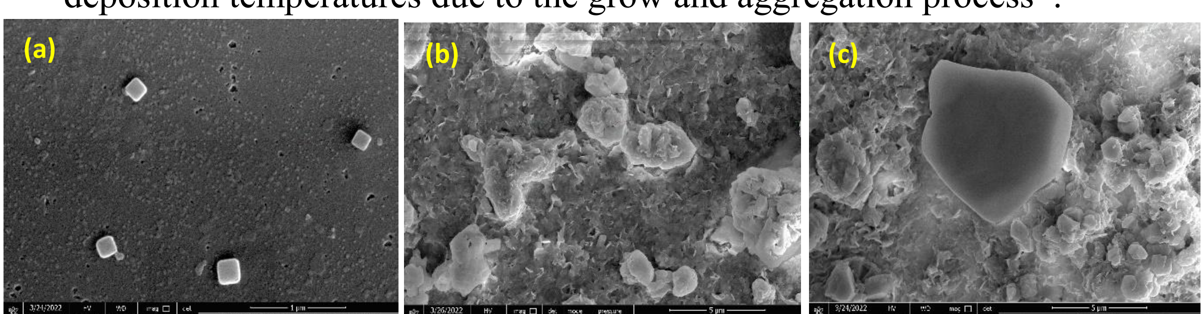

figure (7)SEM images of the films prepared at (a)30°C,(b)70 °C and (c) 85 °C.

4. **Conclusions**:

The thin films of $CoCaO_3$ have been deposed on glass substrate using chemical bath deposition. Different parameters can be changes during the deposition but the most important parameters are the deposition temperature and deposition periods. The layer thickness increases with increasing deposition time, then the process is reversed with increasing deposition time. All the energy gaps also varying with the deposition periods, The SEM images of the films prepared with different deposition periods show a that the grain size at first increase with deposition period then decrease, X-ray spectrum show that the film include both phases crystalline and amorphous and crystalline with average grain size was about 52.67 nm. The transmittance of the $CoCaO_3$ films prepared at different deposition temperatures 30,70 and 85°C were investigated increase with wavelength while the absorbance decrease with wavelength. The energy gaps also changed with deposition temperature, where the energy gap was about 3.35eV for the films prepared at 85°C then decrease to 2.6eV for the films prepared at 70°C and finally decrease to 2.4eV for the films prepare at 30°C . The SEM images show that the grain size at first increase with deposition temperatures.

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