AL BAHIR

Quarterly Refereed Journal
for Natural and Engineering Sciences

Issued by
Al-`Abbas Holy Shrine
International Al-`Ameed Centre for Research and Studies

Licensed by
Ministry of Higher Education
and Scientific Research

Third Year, Fifth Volume, Issue 9 and 10
Ramadhan, 1438, June 2017

Secretariat General
of Al-'Abbas
Holy Shrine

Al-Ameed Interna-
tional center
for Research and Studies

Print ISSN: 5721 – 2312
Online ISSN: 0083 – 2313
Consignment Number in the Housebook and Iraqi
Documents: 1996, 2014
Iraq - Holy Karbala

Mobile: +964 760 235 5555
+964 771 948 7257
http://albahir.alkafeel.net
Email: albahir@alkafeel.net

Publication Conditions

Inasmuch as Al-`Bahir- effulgent- Abualfadhal Al-`Abbas cradles his adherents from all humankind, verily Al-Bahir journal does all the original scientific research under the conditions below:

1. Publishing the original scientific research in the various scientific sciences keeping pace with the scientific research procedures and the global common standards; they should be written either in Arabic or English .
2. The research should not be published before under any means .
3. The research should adhere the academic commonalties; the first page maintains the title, researcher name /names, address, mobile number under condition that the name, or a hint , should never be mentioned in the context and keywords should be written in Arabic and English as there is an abstract in Arabic and English.
4. The Research studies should be delivered to us either via Journal website http://albahir.alkafeel.net , after filling the two standard format the first with the name of the researcher and the second without in Word .
5. The page layout should be (2)cm .
6. The font should be of (16 bold),Time New Roman, subtitles of (14 bold) and also the context.
7. The space should be single, indentation should not be, as 0 before, 0 after and no spacing, as 0 before, 0 after.
8. There should be no decoration and the English numeral should proceed to the last text.
9. Any number should be between two brackets and then measurement unit, for instance: (12) cm .
10. All sources and references should be mentioned at the end of the article and categorized in conformity with Modern Language Association (MLA) , for instance :

Name of Author/ Authors, Journal Name Volume Number (Year) pages from - to.

Similarly done in the Arabic article withy a proviso that superscript should be employed.

11. There should be a caption under a diagram in 10 dark , Arabic and English; for instance:

Title or explanation; number of the Fig.
Similarly done with tables.
12. Diagrams , photos and statics should be in colour with high resolution without scanning.
13. The marginal notes, when necessary, should be mentioned at the end of the article before the references.
14. Wherever there is the word " figure" should be abbreviated as Fig. and table should be Table.
15. The pages never exceed 25 pages.
16. The Formulae should be written in Math Type.
17. All the ideas and thoughts reveal the mindset of the researcher not the journal and the article stratification takes technical standards.
18. All the articles are subject to :
a- The researcher is notified that his paper is received within 14 days in maximum.
b- The article is to be sent to the researcher as soon as it does not meet the requirement of the publication conditions.
c- The researcher is notified that his article is accepted.
d- The articles need certain modification , as the reviewers state, are sent to the researchers to respond in a span of a month from the date of dispatch.
e- The researcher is to be notified in case the article is rejected.
f- The researcher is to be granted an edition containing his article.
19. Priorities are given in concordance to :
a. The articles participated in the conferences held by the publication institute.
b. The date of receiving.
c. The date of acceptance.
d. The importance and originality of the article.
e. The diversity of the fields the articles maintain in the meant edition.
20. The researchers should appeal to the modifications the language and scientific reviewers find in the articles.
21. The researcher should fill the promise paper having the publication rights of the Scientific Al-Bahir Journal and adhering to integrity conditions in writing a research study.

In the Name of Allah
Most Compassionate, Mort Merciful

Edition Word

O Allah, my Lord

Cast felicity in me , facilitate my cause and unknot my tongue to perceive my speech , thanks be upon Him the Evolver of the universe and peace be upon Mohammad and his immaculate and benevolent progeny .

A fledged edition of Al-Bahr , peer reviewed scientific journal, embraces a constellation of research studies pertinent to engineering and natural sciences we do hope to overlap a scientific gap the specialists observe as an academic phenomenon worth being under the lenses of the researchers, that is why there is diversity in the studies to meet the requirements of the journal readership . For the journal, now, comes to the fore , at the efforts of the editorial and advisory boards and the researchers who strain every sinew to publish in Al-Bahr, to be global as to be published in an international publishing house in line with the global scientific journals.

On such an occasion we do pledge the promise of fealty and loyalty to those who observe our issues with love and heed in the International Al-`Ameed for Research and Studies , Department of Cultural and Intellectual Affairs in the Holy Al-`Abbas Shrine and the strenuous endeavour to cull whatever invigorates the scientific interaction and academic research in Iraq and worldwide to create a new generation keeping pace with the development of the current scientific phase and to lay the hands of the researchers, nationwide and worldwide, upon the desired missions.

Thanks be upon Him ,the Evolver ad infinitum .

Consultation and Editaril

Electrical Properties of $(CdO)_{1-x}(SnO_2)x$Thin Films Prepared by Pulsed Laser Deposition

*Nahida B. Hasan, **Ghusson H. Mohammed and *Mohammed A. Abdul Majeed

*Department of physics, College of Science, University of Babylon, Iraq
**Department of physics, College of Science, University of Baghdad, Iraq.

Received Date: 25 / 9 / 2015
Accepted Date: 19 / 6 / 2016

الخلاصة

تم ترسيب أغشية اوكسيد الكادميوم بتراكيز مختلفة من اوكسيد القصدير(0، 0.05، 0.1، 0.15، 0.2) على قواعد زجاجية بتقنية الترسيب بالليزر النبضي ليزر النديميوم ياك ذو طول موجي (1064) نانومتر وطاقة قدرها (600) ملي جول وعدد نبضات (500) نبضة.لها تركيب متعدد التبلور، قياسات التوصيلية المستمرة أثبتت ان التوصيلية تتناقص مع زيادة تركيز SnO2 ودرجة الحرارة التلدين، ووجد ان هنالك طاقتي تنشيط تزداد مع زيادة تركيز SnO2 وتقل مع زيادة درجة حرارة التلدين. أوضحت قياسات تأثير هول ان الأغشية انها من نوع n وان تركيز حاملات الشحنة يتناقص مع زيادة تركيز SnO2 ويزداد مع زيادة درجة حرارة التلدين، بينما اظهرت التحركية سلوك معاكساً لذلك.

الكلمات المفتاحية

اوكسيد الكادميوم، اوكسيد القصدير، تقنية الترسيب بالليزر النبضي.

Abstract

CdO thin films have been deposited at different concentration of SnO2 x= (0.0, 0.05, 0.1, 0.15) and (0.2) Wt. % onto glass substrates by pulsed laser deposition technique (PLD) using Nd-YAG laser with λ=1064 nm, energy= 600mJ and number of shots= 500. For it polycrystalline, the D.C. conductivity for the $(CdO)_{1-x}(SnO_2)_x$ thin films decreases with increasing concentration SnO2 and decreases with increasing of annealing temperature, found two activation energies increases with increasing concentration SnO2 and decreases with increasing of annealing temperature. Hall effect measurements show that the $(CdO)_{1-x}(SnO_2)_x$ thin films were n-type, concentration of charge carriers nH decreases with increasing of concentration of SnO_2, also charge carriers nH increases with increasing of annealing temperatures, while the mobility μH opposite behavior.

Keywords

Cdo, SnO_2, pulsed laser deposition.

1.Introduction

An important branch that has been developed in the last decades is the physics of thin films. Thin solid films were probably first obtained by electrolysis in 1838.Bunsen and Grove obtained metal films in 1852 by means of chemical reaction and glow discharge sputtring respectively. Faraday obtained metal films in 1857 by thermal evaporation on explosion of a current carrying metal wire [1]. Cadmium Oxide CdOthe unique combination of cardio thin film properties which were represented by high electrical conductivity, high carrier concentrations and high transparency in the visible range of the electromagnetic spectrum, made it suitable for a wide range of applications in different fields [2]. Stannic Oxide SnO_2 in 1942 Masters succeeded in preparing conductive transparent tin oxide, for the first time. A substance with white color has a molecular weight of (150. 69) g/mol. Its density (6.95) g/cm^3, its melting point (1630)°C and its boiling point (1900)°C [3]. Stannic oxide is an n- type semiconducting material with a direct band gap of about 4.0 eV and an indirect band gap of about 2.6 eV [4].

2. Experimental

2.1. Preparation Pellets

High purity powders (99.999%) of CdO and SnO_2 supplied from Fluka were used to form the target as a disk of (2.5) cm diameter and (0.4) cm thickness by pressing it under (4) ton force. The pellets which containing the elements were heated to (873) K for (3) hours then cooled to room temperature. The temperature of the furnace was raised at a rate of (10) °C/min. The amount of elements content of pellets was evaluated by using the following equation.

$$W_{(CdO)_{1-x}(SnO2)_x} = W_{CdO} \times (1-x) + W_{SnO_2} \times (x) \ldots\ldots (1)$$

Where: atomic weight for CdO), =150. 69 (atomic weight for SnO_2) and (x=0, 0.05, 0.1, 0.15 and 0.2) (concentration of SnO_2).

2.2. PLD and Thin Film Preparation

The $(CdO)_{1-x}(SnO_2)_x$ films were deposited on glass slides substrates of (2.5×7.5) cm^2 were cleaned with dilated water using ultrasonic process for (15) minutes to deposit the films at room temperature by PLD technique using Nd:YAG with (λ= 1064) nm SHG Q-switching laser beam at (600) mJ, repetition frequency (6) Hz for (500) laser pulse is incident on the target surface making an angle of (45°). The under vacuum of (10^{-3}mbar) at room temperature and annealing temperatures (423 and 523) K were presented.

2.3. D.C. Conductivity Measurements

D.C. electrical conductivity of $(CdO)_{1-x}(SnO_2)_x$ thin films were deposited on the glass substrates, and it was measured using electrical resistance as a function of temperature within the thermal range (303-473) K. This can be done by putting the thin film in an electrical oven of the type (Memmert). Silver paste was used to fix connection wires on the poles, these wires are connected to the circuit. The resistance of thin film has been measured by connecting the wires to digital electrometer (Keithely 2400). Values of resistance have been measured as a function of temperature.

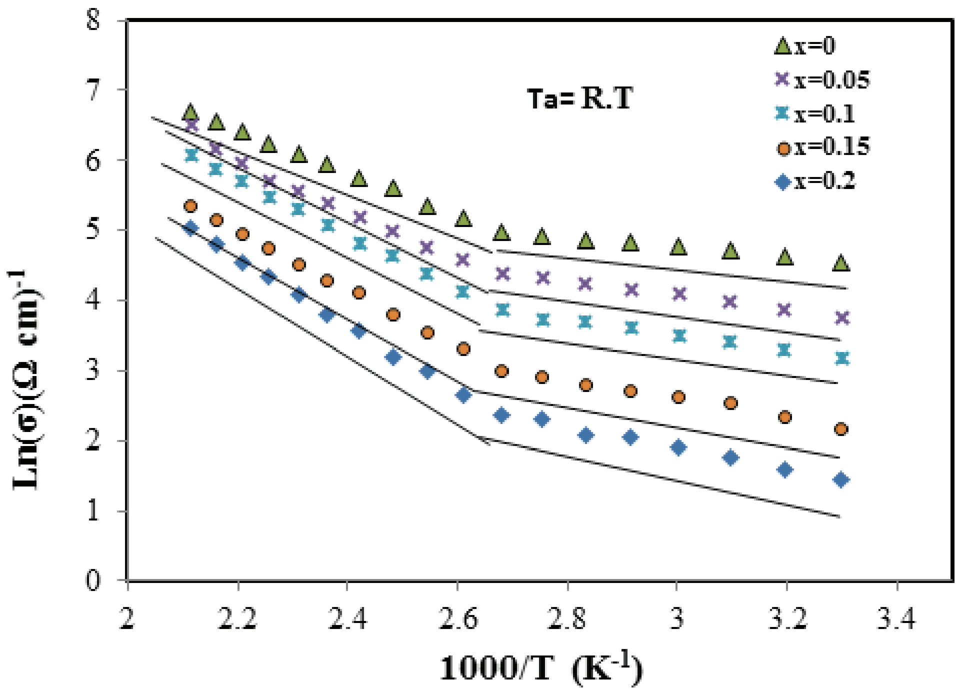
3. Results and Discussion

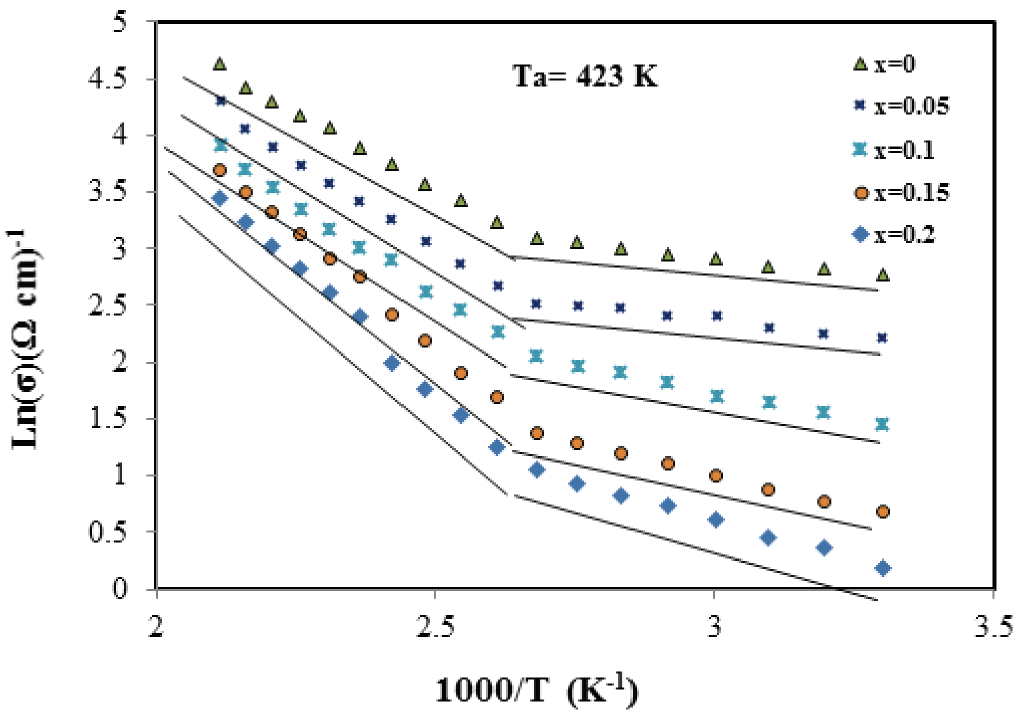
3.1. The Electrical Properties

3.1.1. D.C Conductivity

In order to study the mechanisms of conductivity, it is convenient to plot logarithm of the conductivity Ln (σ) as a function of 1000/T for $(CdO)_{1-x}(SnO_2)_x$ thin films with different concentration of SnO_2 (x=0, 0.05, 0.1, 0.15 and 0.2) at room temperature and different annealing temperatures (423 and 523) K, as shown in Fig. (1). It is clear from these Figures that there are two transport mechanisms, giving rise to two activation energies Ea_1 and Ea_2. At the higher temperature range (373-473) K, the conduction mechanism is due to carrier excited into the extended states beyond the mobility edge and at a lower temperature range (303-373) K. The conduction mechanism is due to carrier excited into localized states at the edge of the band [5]. It is observed that the activation energies increase while σ_{RT} decreases with the increasing of concentration of SnO_2 and the activation energies decrease while σ_{RT} increase with increasing of annealing temperatures as represents in Table (1). The activation energy Ea_1 for $(CdO)_{1-x}(SnO_2)_x$ films increases with increasing of concentration of SnO_2, from (0.057 to 0.132) eV, from (0.041 to 0.118) eV and from (0.038 to 0.101) eV when range temperature changes from (303 to 373) K at (x=0, 0.05, 0.1, 0.15 and 0.2)respectively, also the activation energy Ea_1 decrease with increasing of annealing temperatures as shown in Figure (2), while Ea_2 increases from (0.262 to 0.408) eV, (0.23 to 0.375) eV and (0.178 to 0.313) eV when range temperature changes from (373 to 473) K at (x= 0, 0.05, 0.1, 0.15 and 0.2) respectively, also the activation energy Ea_2 decrease with increasing of annealing temperatures, as shown in Fig. (3).The behavior of E_a with SnO_2 concentration and annealing temperature is the same as that for E_g^{opt}. When E_g^{opt} increases, the carriers need high activation energy E_a to transport them from V.B to C.B and vice versa [6]. From the Table (1), it can also be observed that the activation energy of the first region is less than that of the second region. This can appear in some compounds, where the carrier density could be small enough to give this behavior [7]. From Figure (4) and Table (1), we can observe that $\sigma_{R.T}$ decreases with increasing of annealing temperatures but decreases with increasing of concentration of SnO_2. The decreases in the conductivity with concentration of SnO_2 is obviously due to the decrease in the carrier concentration as well as in the absorbance i.eincrease in the mobility while the explanation for decreasing in the conductivity with increasing of annealing temperature because of the rearrangement that may occur during annealing [8]. The activation energies could be calculated from the plot of lnσ versus 1000/T according to equation [9].

$$\sigma = \sigma_o \exp(-E_a / k_B T) \quad \ldots\ldots(2)$$





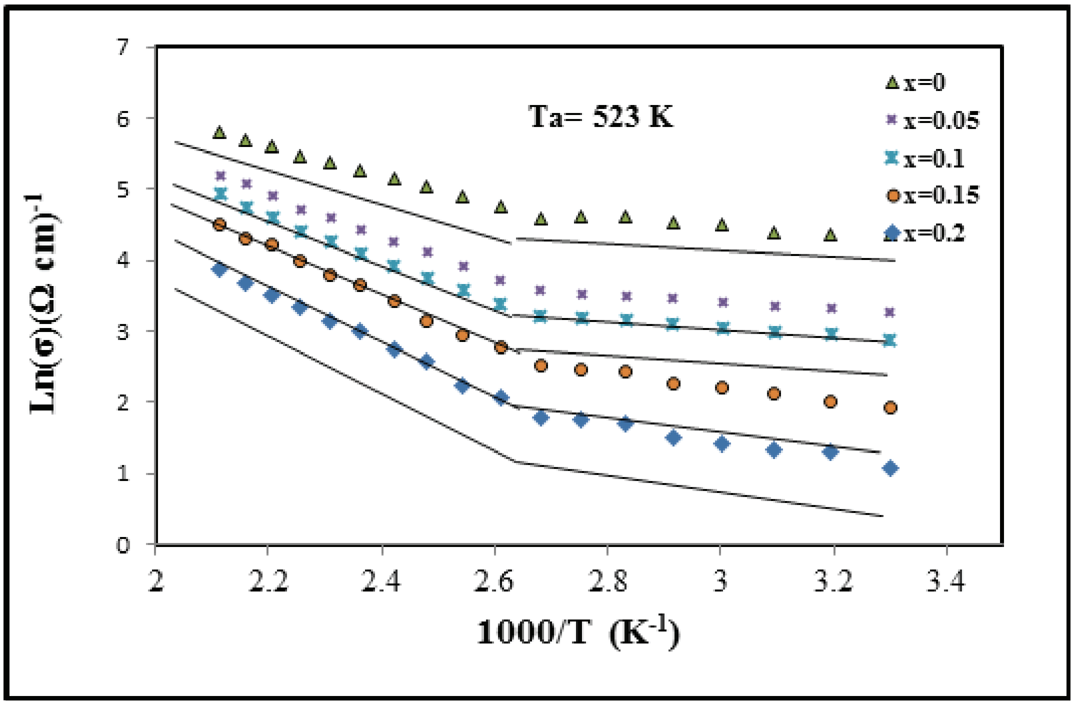


Fig. (1): The relation between Ln (σ) versus reciprocal of temperature for $(CdO)_{1-x}(SnO_2)_x$ thin films with different concentration of SnO_2 at R.T and different annealing temperatures(432 and 523)K.

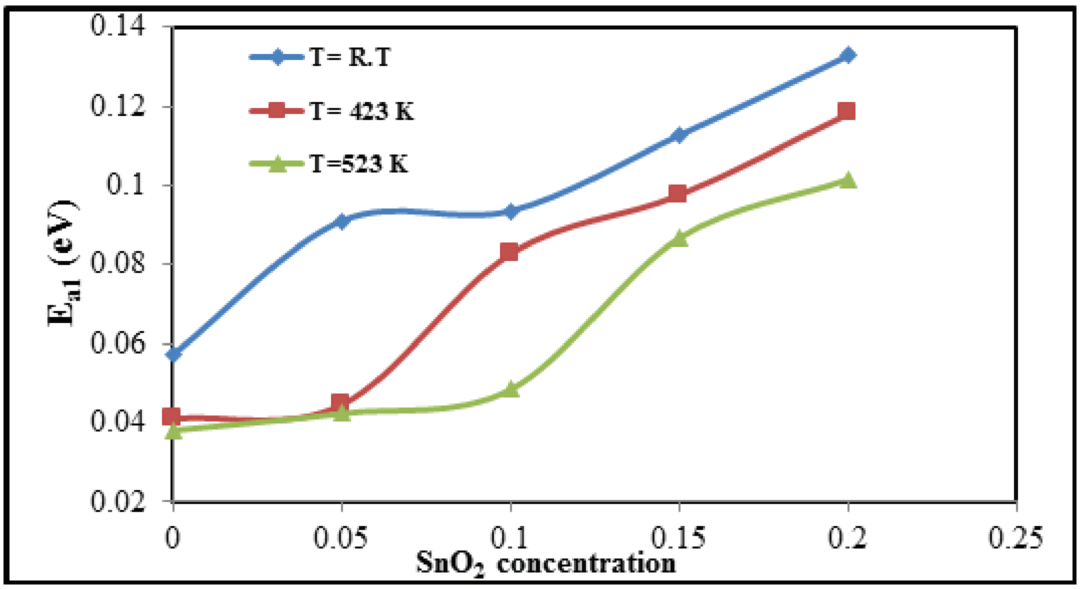


Fig. (2): The variation of the activation energy Ea_1 for $(CdO)_{1-x}(SnO_2)_x$ thin films with different concentration of SnO_2 at R.T and differentannealing temperatures (423 and 523) K.

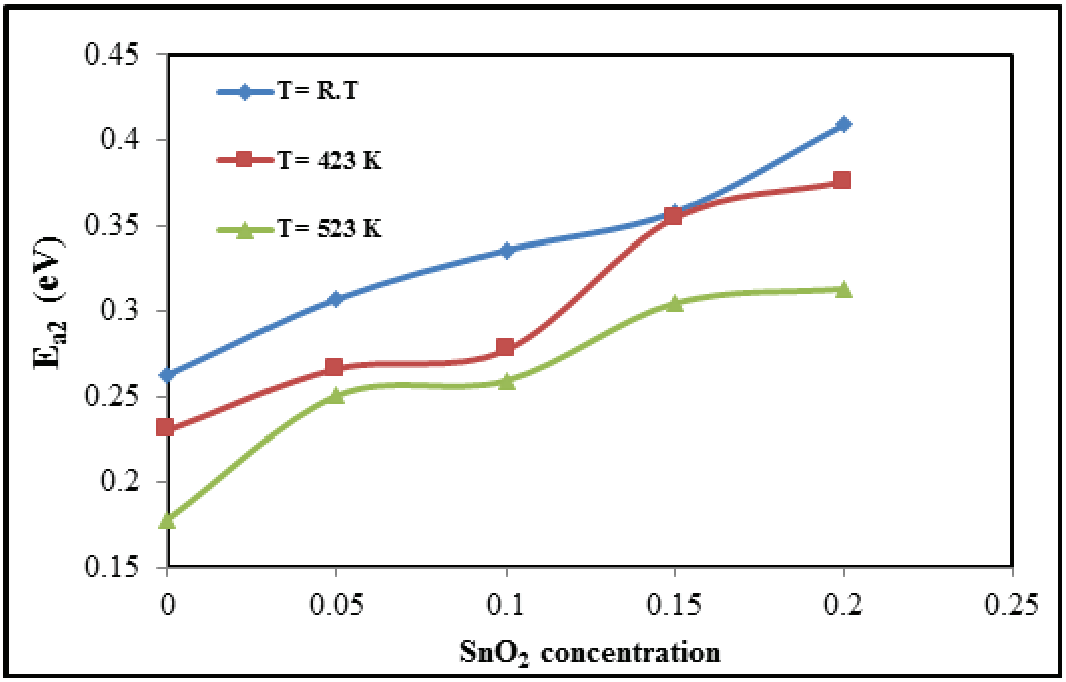


Fig. (3): The variation of the activation energy Ea_2 for $(CdO)_{1-x}(SnO_2)_x$ thin films with different concentration of SnO_2 and differentannealing temperatures (423 and 523) K.

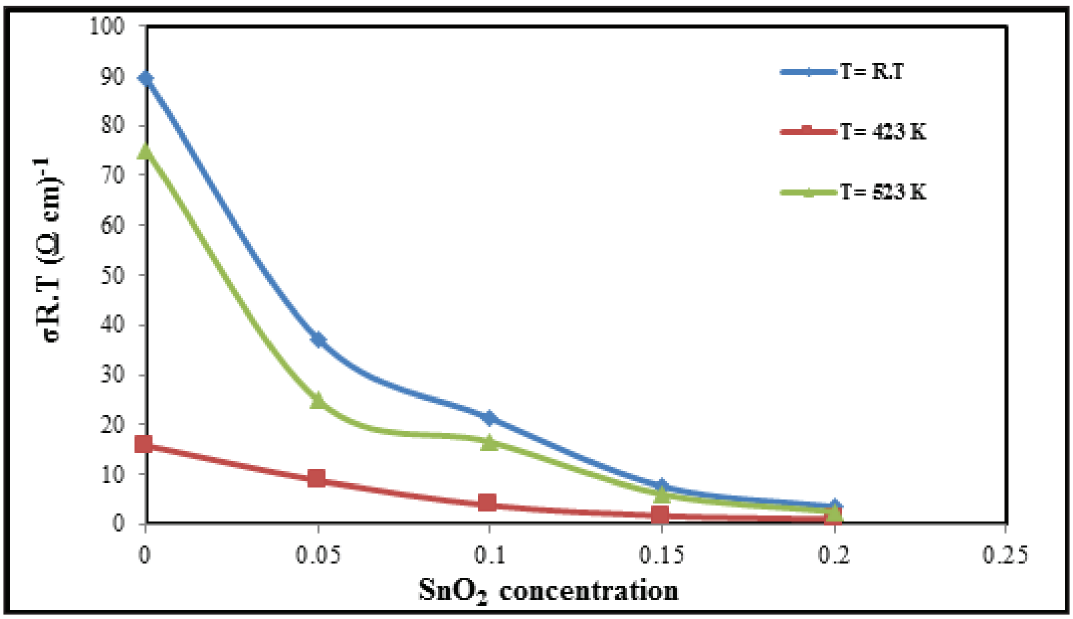


Fig. (4): The variation of conductivity $\sigma_{R.T}$ for $(CdO)_{1-x}(SnO_2)_x$ thin films with different concentration of SnO_2 at R.T and differentannealing temperatures (423 and 523) K.

Table (1):The values of E_{a1} and E_{a2} and these ranges for $(CdO)_{1-x}$ $(SnO_2)_x$ thin films with different concentration of SnO_2 and different annealing temperatures(423 and 523) K.

T_a (k)	x	$\sigma_{R.T}$ Ω cm)$^{-1}$)	E_{a1} (eV)	Range (Temp.(K	E_{a2} (eV)	Range (Temp.(K
R.T	0	95.164	0.059	303-373	0.263	373-473
	0.05	42.249	0.089	303-373	0.307	373-473
	0.1	24.025	0.093	303-373	0.336	373-473
	0.15	8.671	0.110	303-373	0.358	373-473
	0.2	4.263	0.130	303-373	0.409	373-473
423	0	15.968	0.041	303-373	0.230	373-473
	0.05	9.117	0.046	303-373	0.266	373-473
	0.1	4.279	0.082	303-373	0.277	373-473
	0.15	1.982	0.098	393-373	0.354	373-473
	0.2	1.209	0.118	303-373	0.375	373-473
523	0	78.241	0.040	303-373	0.178	373-473
	0.05	26.558	0.042	303-373	0.250	373-473
	0.1	17.895	0.047	303-373	0.259	373-473
	0.15	6.817	0.087	303-373	0.305	373-473
	0.2	2.945	0.098	303-373	0.313	373-473

3.1.2. Hall Effect

The type of charge carriers, concentration (n_H) and Hall mobility (μ_H), has been estimated by using (Ecopia HMS-3000) for Hall Measurement Systems. Table (2) shows the main parameters estimated from Hall effect measurements for $(CdO)_{1-x}(SnO_2)_x$ thin films deposited with different concentration of SnO_2 (x=0, 0.05, 0.1, 0.15 and 0.2) at room temperature and different annealing temperatures (423 and 523) K. We can notice from this Table that the films have a negative Hall coefficient. This mean that the type of conducting (n–type charge carriers).Also we can notice from Table (2), that the carrier's concentration (n_H) decreases with the increasing of concentration of SnO_2, while Hall mobility (μ_H) increases with the increasing of concentration of SnO_2, while Hall coefficient increases with increasing, also the carrier's concentration

(n_H) increases with the increasing of annealing temperatures, while the Hall mobility (μ_H) decreases with the increasing of annealing temperatures, also Hall coefficient decreases with increasing temperature.This may be due to the decrease in defects inside the energy gap and to the transformation to crystalline structure.It can be seen that the carrier mobility increases with decreasing the carrier concentration which is due to the increase in concentration of SnO_2 and vice versa. The decrease of mobility in higher temperature is caused by lattice scattering of charge carriers, also the large value of carrier concentration determines a decrease of the mobility [10]. We can measure the Hall mobility as [11].

$$\mu = \frac{\sigma}{n.e} \quad \text{..........................} (3)$$

$$\mu = \sigma |R_H| \quad \text{..........................} (4)$$

Table (2): Hall effect measurements for $(CdO)_{1-x}(SnO_2)_x$ thin films with different concentration of SnO_2 at R.T and different annealing temperatures (423 ad 523) K.

Ta (K)	x	$n_H \times 10^{18}$ cm)$^{-3}$)	$R_H \times 10^{-2}$ (cm^3/C)	$\mu_H \times 10^1$ (cm^2/V.s)	Type
R.T	0	0.308	0.060	0.007	n
	0.05	0.218	0.085	0.015	n
	0.1	0.163	0.114	0.030	n
	0.15	0.028	0.668	0.031	n
	0.2	0.001	12.2	0.300	n
423	0	0.641	0.029	0.038	n
	0.05	0.492	0.038	0.022	n
	0.1	0.272	0.068	0.029	n
	0.15	0.196	0.095	0.113	n
	0.2	0.002	6.25	1.33	n
523	0	4.373	0.004	0.004	n
	0.05	2.547	0.007	0.005	n
	0.1	1.438	0.013	0.008	n
	0.15	0.701	0.026	0.037	n
	0.2	0.122	0.153	0.070	n

4. Conclusions

The activation energies increases with increasing concentration of SnO_2 and decreases with increasing of annealing temperatures. Hall measurements showed that all the thin films are n-type.

References

[1] K.L Chopra, "Thin Films phenomena", McGraw Hill Inc, USA, (1969).

[2] X. Li, T. Gessert, C. Dehart, T. Barnes, J. Perkins and T. Coutts, proceeding of the NCPV Program Review Meeting, Colorado, (2001).

[3] D. K. Lide,"Chemical Rubber Company Hand Book of chemistry and physics", CRC press, Boca Raton, Florida, USA, 77th ed., (1996).

[4] J. E. Macintyner,chapman and Hall, London, UK, Vol. 1-3, (1992).

[5] N. F. Mott and E. A. Davis, "Electronic processes in non-crystalline materials", Oxford University Press, 2nd ed., (1979).

[6] N. Qamhieh, H. Ghamlouche, S. T. Mahmoud, H. Al-Shamisi and S. Ahmad," J. Ovonic Research, Vol. 3, pp. 51-55, (2007).

[7] M. Abdel-Satar , M. Abdel-Rahim and A. El-Kurash, International J. Pure and Applied Physics, Vol. 3, pp. 59-68, (2007).

[8] H. M. Abbas, "Structural, Optical and ElecteicalPropertise of Sb2 (1-x) Se3 Thin Films by Pulse Laser Deposition Technique", M. Sc. Thesis,University of Babylon, (2014).

[9] P. Kireev, "Semiconductors physics", MIR Puplishers, Translated from Russian by M. Samokhvalov, Moscow, (1978).

[10] H.F. Wolf, «Semiconductors», Wiley (NY), (1971).

[11] A. Islam, M. Islam, M. Choudhury and M. Hossan, «Recent development in condensed matter physics and nuclear science», J. Rajshahi University, Bangladesh, p. 1969, (1998).