Structural and electrical properties of CdS &CdS:Sb thin films prepared by flash evaporation technique

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الخلاصة

استخدمت سبيكة CdS لتحضير اغشية CdS واغشية CdS المشوبة بعنصر الانتيمون Sb (CdS:Sb) بنسبة وزنية (3٪) بتقنية التبخير الوميضي على ارضيات زجاجية بسمك (150) نانومتر بدرجة حرارة الغرفة. تم دراسة تاثير التشويب و درجة حرارة التلدين (373 و473) كلفن لمدة (60) دقيقة على الخواص التركيبة و الكهربائية لجميع الاغشية . قياسات الاشعة السينية اوجدت ان الاغشية (CdS , CdS:Sb) المحضرة بدرجة حرارةالغرفة والملدنة بدرجة حرارة (373) كلفن هي من النوع العشوائي و بزيادة درجة حرارة التلدين الى (473) كلفن وجد ان الغشاء CdS النقي يتحول الى طور متعدد البلورات السداسي و باتجاه نمو مفضل (002) وان الغشاء المشوب بعنصر الانتيمون CdS:Sb يتحول الى متعدد البلورات بشكل مكعب وبأتجاه نمو مفضل (111) . من خلال دراسة التوصيلية الكهربائية المستمرة تم حساب قيم طاقات التنشيط و التوصلية المستمرة ، حيث وجد ان قيم طاقات التنشيط تزداد بزيادة درجة الحرارة وتقل بأضافة عنصر الانتيمون(تقل بالتشويب) وان التوصيلية المستمرة سلكت سلوك معاكس لطاقات التنشيط. من خلال قياسات تأثير هول وجد ان حاملات الشحنة هي من النوع n-type لجميع الاغشية وان تركيز حاملات الشحنة يقل بزيادة درجة حرارة التلدين بينما التحركية تزداد . تركيز حاملات الشحنة والتحركية أزداد بعد اضافة عنصر الانتيمون الى اغشية CdS.

الكلمات المفتاحية

كبريتيد الكادميوم، كبريتيد الكادميوم CdS المشوبة بعنصر الانتيمون Sb ، تقنية التبخير الوميضي.

Abstract

CdS alloy used to prepareCdS and CdS doped Sb (3%) (CdS:Sb) filmsby flash evaporation technique with thickness (150) nm on glass substrate at room temperature. The effect ofdoping and the annealing temperature at (373 and 473) K for (60) min on the structural and electrical propertieshas been described. The XRD studies show that theannealed film at (373) K has amorphous structure and alters to the polycrystalline at)473(K where the CdS film growth to hexagonal structure with perfect orientation (002) and CdS:Sb growth to cubic structure with perfect orientation (111). From D.C conductivity the variation of activation energies (Ea1,Ea2) and D.C conductivity at room temperature were measured.It is found that Ea2 values decreasing for doped films and increase with increasing annealing temperature (Ta) for all film. Hall Effectshows that all films are n-type, carrier's concentration decrease with increasing of annealing temperature while Hall mobility increases. Carrier'sconcentration and Hall mobility increases after adding the doped material (Sb) to the CdS films.

Keywords

CdS ,CdS:Sb , flash evaporation technique.

1. Introduction

In the last years, the world has been increment proceeding to II–VI semiconductor materials because of its wide range of technical and industrial applications especially in the optoelectronic devices: solar cells, diode, transparent electrode, photo transistor, optical sensor, etc. Cadmium sulfide (CdS) had actually yellow color, two crystal structure cubic and hexagonal phases [1]. CdS isn-type semiconductor having a direct energy band gap between 2.28-2.45 eV [2].The energy gap of CdS thin film be influenced by preparation conditions such as substrate temperature, annealing-temperature, thickness, doped, etc[3]. More techniques were used to prepared CdSfilms such as “thermal evaporation” [4], “molecular beam epitaxy (MBE)”[5], “spray pyrolysis” [6], “electro-deposition”[7], pulsed-laser deposition [8] ,“successive ionic layer adsorption and reaction (SILAR)” [9],“vacuum evaporation” [10] ,”chemical bath deposition (CBD)” [11], and sputtering [7]. The characteristic of structure, electrical and many properties of CdS thin film can be controlling that lead to wide range of band gap value.

The aim of present work is to prepared CdS and CdS doped Sb (3%) CdS:Sb films by flash evaporation technique and study the structural and electrical properties of it. The electrical properties will calculate from D.C conductivity and Hall measurement.

2. Experimental procedure

CdS powder and antimony (99.99%) Sb used to prepared CdS and CdS:Sb thin film with thickness 150 nm on glass substrate. There are several step during film prepare at first cleaned the glass slide with distilled water and use ultra-sonic and alcohol to cleaning the glass from impurity.

There are different techniques to prepare the thin film and these techniques depending on many fact or slike melting point, substrate, thickness, etc. In this research, there is used flash evaporation technical has used because the material have different melting point. Cadmium sulfide (CdS) and Cadmium sulfide were doped with antimony (CdS:Sb) with thickness (150) nm deposited on the glass substrates by the method of flash thermal vacuum evaporation (Edward E 360) using molybdenum boat under vacuum pressure(10-5) mbar as shown in fig (1). The electric current was gone through the boat step by step to avoid breaking it, the affidavit procedure begins at the vessel temperature achieved the required temperature. Every one of the samples were set up under consistent conditions (weight, substrate temperature and rate of deposited). The doping and annealing temperature (373 and 473)K was the primary parameters that control the film properties.

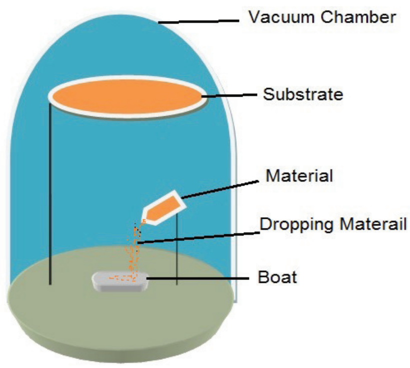


Fig. (1): Flash thermal evaporation technical

Ohmic contacts has been doneto study the electrical properties ofCdS&CdS:Sb thin films by evaporating (Aluminum) electrodes of (250) nm thickness,by means of thermal evaporation method using Balzersmodel(BL510) with pressure(10-5) mbar.Interference microscopeare used to measure the (CdS&CdS:Sb) film thicknesses .

CdS and CdS:Sb structure were studied by X-ray diffraction and compared with standard value in ASTM, and used a Philips X-ray diffractometer system which records the intensity as a function of Bragg's angle.

The D.C conductivity of the films was calculated using the electrical circuit which is consists of oven and keithly digital electrometer 616 to measure the resistance as function oftemperature.

The DC conductivity was determined from the relation [12]:

$$\sigma_{d.c.} = \frac{1}{\rho} = \frac{L}{R\,A} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

whereR :film resistance, A : cross section area of the film and L: distance between the electrodes. The activation energies have been calculated from the plot of Ln σ versus 1000/T according to the following relation[13].

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

Whereσo: the pre-exponential factor,kB is the Boltzman's constant,Ea: the activation energy and T: the temperature.

Hall effect measurement carried out to determine the type, mobility and the carriers concentration of CdS&CdS:Sb thin films using Hall measurement (Ecopia HMS-3000).

Hall mobility (μH) determined by using the following relation[13] :

$$\mu_H = |R_H| \,.\, \sigma_{RT} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

1

Where σRT is the electrical conductivity at room temperature and RH is the Hall coefficient , while the carrier concentration (n) can be determined using the relation[13] :

$$n = \frac{1}{|R_H|\,.e} \quad \ldots\ldots\ldots (4)$$

Where (e) is electron charge.

3. Results and discussion

3.1. X-Ray

X-ray diffraction pattern (XRD) of CdS and CdS:Sb of thickness 150 nm for the as deposited film and annealed to (373 and 473) K are shown in Fig.(2).X-ray pattern show that theCdS and CdS:Sb films have amorphous structure for as deposited and annealed film at (373)K . CdS film was growth to hexagonal structure with perfect orientation (002) at (473)K andCdS:Sbgrowth to cubic structure with perfect orientation (111). Thisresult agreement with Mehdi H. Diwan[14] for pureCdS films .So, the addition of antimony leads to change the structure of CdS from hexagonal to cubic structure that may be due to fill the vacancy in CdS structure by Sb.

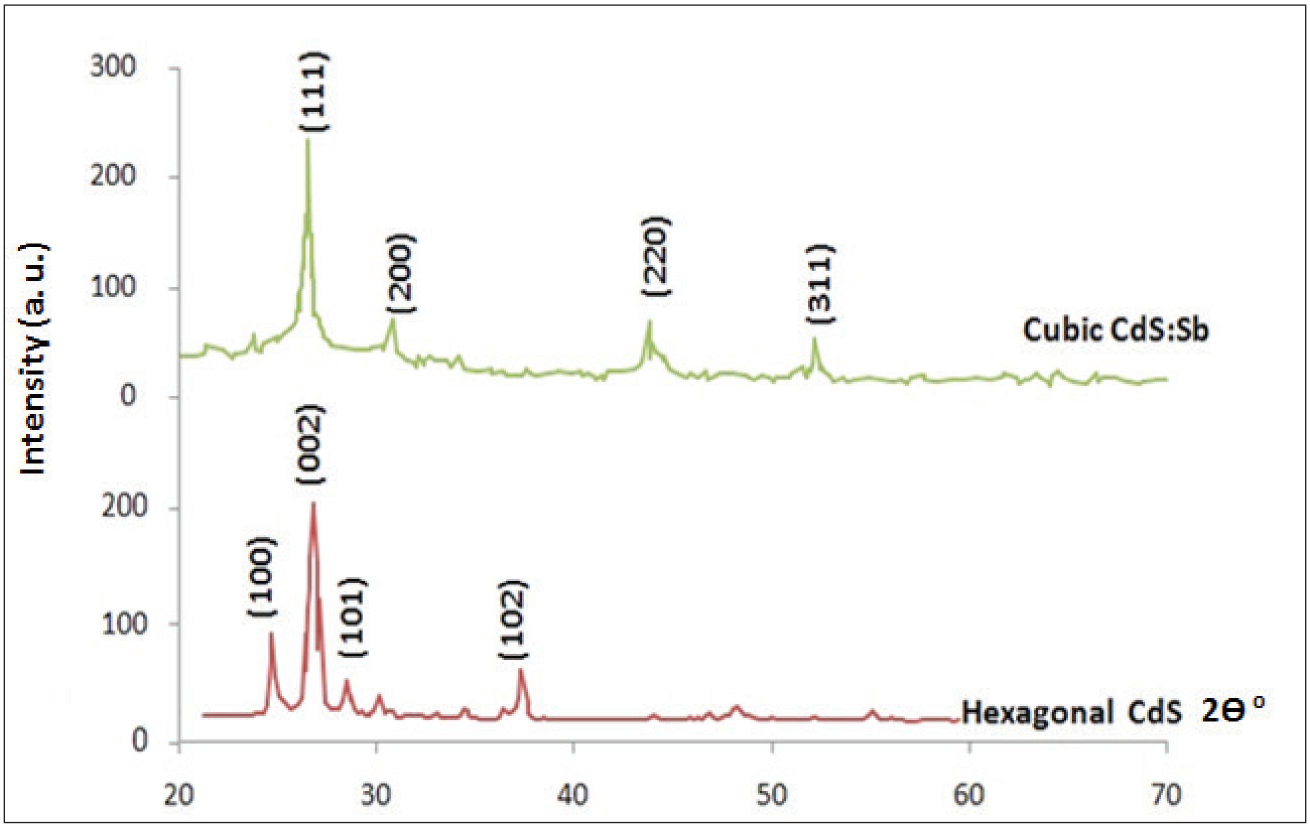


Fig. (2): XRD of annealedCdS and CdS:Sbthin films at (473)K

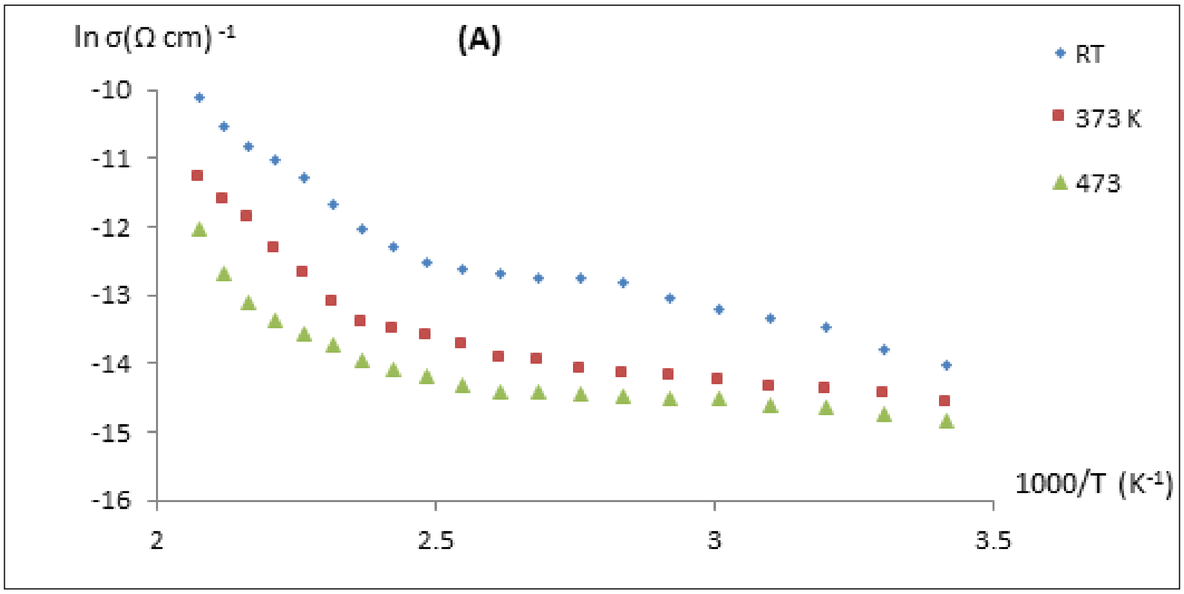
The experimental data of the (2θ) degree,hkl& I/I max for CdS and CdS:Sb films at (473)Kwhich compared with the standard value in ASTM are presented in Table (1).

Film	hkl	.2θ Exp	2θ° standard	I/I_{max}	Crystal structure
CdS	(100)	24.809	24.807	41.6	Hexagonal
	(002)	26.508	26.507	100	
	(101)	28.186	28.182	19.5	
	(102)	36.619	36.620	24.5	
CdS:Sb	(111)	26.49	26.506	100	cubic
	(200)	30.798	30.807	29.9	
	(220)	43.786	43.96	29.4	
	(311)	52.121	52.132	22.7	

3.2. D.C Conductivity

Fig.(3) showsthe variation of lnσ as a function of 1000/T.The activation energy (Ea) and the electricalconductivity in the room temperature (σRT) for CdS&CdS:Sb films have been studied as a function of different annealing temperature Ta. The electricalconductivity show that there are two activation energies

(Ea1& Ea2),this result provesthe structure of CdS and CdS:Sb area polycrystalline thin films . The second activation (Ea2) energies increases with increasing of Ta and decrease with doped material. Table (2) show thatthe electrical conductivity(σRT)decreases with increasing of annealing temperature and increase with doped material. Nahida B. Hasan et al[15] noticed some behavior for annealing temperature effect.This comportment could be explain as follows: the annealing processes perform to rearrange the crystalline build that lead to reduction the density of state and the dangling bonds in the band gap, which leads to increasing the energy gap and activation energy.So, the carrier's concentration has been decreases and this caused a decrease in the σR.T.



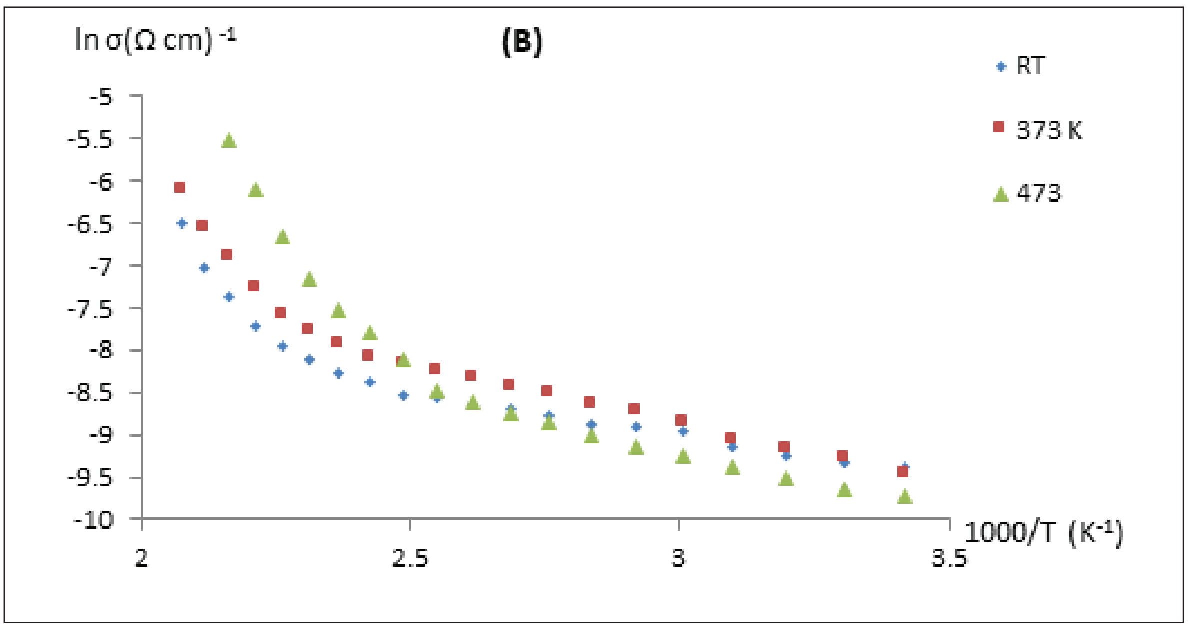


Fig.(3): The variation of Lnσvs. 1000/T, **(A) for CdS , (B) for CdS:Sb**

Table (2): shows (Ea1 , Ea2 , σRT) for CdS and CdS:Sb films

Film	T_a K	(E_{a1}(eV	(E_{a2}(eV	σ_{RT} $(\Omega\ cm)^{-1}$
CdS	RT	0.140	0.537	8.33E-07
	373	0.079	0.637	4.90E-07
	473	0.044	0.841	3.73E-07
(CdS:Sb (3%	RT	0.085	0.504	8.59E-05
	373	0.119	0.538	8.06E-05
	473	0.125	0.582	6.19E-05

3.3. Hall effect measurement

Hall measurements show that all these films have a negative Hall coefficient (n-type charge carriers). This result are agreement with R. DEMIRa et al [1] and Y. CHEN et al[16]. Table (3)shows the data of the carrier's concentration and Hall mobility as a function of annealing temperature for CdS&CdS:Sb films. This table show that the carrier's concentration decreases with increasing of annealing temperature while Hall mobility increases. This behavior isdue to the re-arrangement process, which leads to reduce the density of state and that make the charge carrier's move freelyin the film. So, for that case the mobility is increasing.

Table (3): show the carrier's concentration and Hall mobility for CdS&CdS:Sb films

Film	T_a K	(μH (cm^2/V .S	(n (cm^3
CdS	RT	359.1	x 10^{12} 1.4903
	373	401	x 10^{11} 8.012
	473	463.5	x 10^{10} 5.62
(CdS:Sb (3%	RT	397.3	x 10^{11} 4.931
	373	473.6	x 10^{10} 7.166
	473	610.4	x 10^{10} 1.197

4. Conclusion

X-ray pattern show that the CdS and CdS:Sb films have amorphous structure for as deposited annealed film at (373)KCdS film was growth to hexagonal structure with perfect orientation (002) at (473)KCdS:Sb growth to cubic structure with perfect orientation (111)at 473. There are two activation energies (Ea1& Ea2) , Ea2 increases with increasing of Ta and decrease with doped material. Hall effectshows that all films aren-type. Carrier's concentration decrease with increasing of annealing temperature while Hall mobility increases.Carrier's concentration and Hall mobility increaseswith doped material (Sb) to the CdS films.

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References

[1] R. DEMIRa*, F. GODEb . Chalcogenide Letters, Vol.12, p. 43 (2015).
[2] A. Kariper, E. Guneri, F. Gode, C. Gumus, T. Ozpozan, Mater. Chem. Phys. Vol.129, p.183-188 (2011).
[3] Salma M. Shaban , JOURNAL OF KUFA – PHYSICS Vol.7, No.2 (2015)
[4] [4]Heba Salam Tareq Eng. & Tech. Journal , Vol.32,Part (B), No.2, (2014).
[5] Mohammed A. Kadhim ,Journal of Kerbala University , Vol. 14 No.2 Scientific (2016).
[6] S.J. Ikhmayies, R.N.A. Bitar, Appl. Surf. Sci. 256, p.3541 (2010).
[7] C. Lu, L. Zhang, Y. Zhang, S. Liu, G. Liu, Appl. Surf. Sci. Vol.319,p. 278 (2014).
[8] J.C. Orlianges, C. Champeaux, P. Dutheil, A. Catherinot, T.M. Mejean, Thin Solid Films Vol.519, p.7611-7614 (2011).
[9] K. GowrishRao, V.K. Ashith, J. Phys. Chem. SolidsVol.77, 14 (2015).
[10] M. Tomakin, M. Altunbaş, E. Bacaksiz, Ş. Çelik, Thin Solid Films,Vol.520, p.2532 (2012).
[11] S.U. Shaikh, F.Y. Siddiqui, D.J. Desale, A.V. Ghule, F. Singh, P.K. Kulriya, R. Sharma, Radiation Phys. Chem. Vol.106, p193 (2015).
[12] SZe .M. and Kowk. K. N., ''Physics of Semiconductor Devices'', John Wiley and Sons,3rd Ed(2007).
[13] Fatin. G. Hachim, Baghdad Science Journal. Vol. 11, No.3(2014).
[14] Mehdi H. Diwan , DIYLALA Journal For pure science , Vol.10 No.2, (2014).
[15] Nahida B. Hasan,Ahmed S. Hussian and Kadhim A. Aadim Journal of Babylon University/Pure and Applied Sciences, Vol.22 , No.2 (2014).
[16] Y. CHEN, F. WANG, H. XU, S. REN, H. GU, L. WU, W. WANG, L. FENG , Chalcogenide Letters Vol. 14, No. 1,p. 1 – 9 (2017).

Effect of Bisphenol-A- on Some Biochemical and Hematological Parameters of Female Rats(Rattus Norvegicus)

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الخلاصة

يعد البسفينول-أ- أحد المواد المعرقلة لعمل الغدد الصم. وقد تضمنت الدراسة الحالية الكشف عن تأثير البسفينول-أ-على بعض المعايير الكيموحيوية والدموية مثل , Glucose ALT, AST وعدد خلايا الدم الحمروتركيز الهيموكلوبين في الدم وعدد خلايا الدم البيض والعدد التفريقي لخلايا الدم البيض. أربع وعشرون أنثى جرذ قسمت عشوائيا الى ثلاث مجاميع (8 حيوانات لكل مجموعة). تضمنت حيوانات المجموعة الأولى السيطرة السالبة والثانية هي مجموعة السيطرة الموجبة تناولت المحلول الملحي وزيت الذرة فمويا على التوالي، بينما أناث الجرذان للمجموعة الثالثة تناولت البسفينول-أ-المعلق بزيت الذرة (250 ملغم/ كغم من وزن الجسم) فمويا وعملت كمجموعة معاملة .أظهرت نتائج الدراسة الحالية ارتفاعا معنويا (P≤0.05) في مستويات Glucose ALT وAST وعدد خلايا الدم البيض ونسبة الخلايا الدم البيض العدلة بينما هناك نقصان معنوي(P≤0.05) في عدد خلايا الدم الحمر وتركيز الهيموكلوبين ونسبة الخلايا الدم البيض اللمفية في المجموعة المعطية البسفينول-أ- بالمقارنة مع مجاميع السيطرة بينم هناك تغيرات غير معنوية في نسبة الخلايا الوحيدة والحمضة والقعدة من نتائج الدراسة الحالية نحن نستنتج بأن البسفينول أ يؤدي الى حدوث نتائج سلبية على المعايير الدموية والكيموحيوية. .

الكلمات المفتاحية

البسفينول-أ- ، المعايير الكيموحيوية والدموية ALT, AST ، جرذ .

Abstract

Bisphenol A (BPA) is one of the manufacturing compounds. The present study was conducted to investigate effect of BPA on some biochemical and hematological parameters such as Alanine Aminotransferase (ALT), Aspartate Aminotransferase(AST) Glucose, Red blood cells (RBCs), Hemoglobin (Hb), White blood cells (WBCs) and differential WBCs. Twenty four female rats were used and divided into three groups (8 animals for each group) randomly. Animals of first group was negative control group and second group was positive control group received normal saline and corn oil orally respectively,while female rat of third group were received BPA suspended with corn oil (250mg/kg B.W/day) orally as treatment group for 30 days . Results of the present study revealedsignificant increase ($P \leq 0.05$) in serum level of ALT, AST, Glucose, WBCs counts and percentage of neutrophil but there is significant decrease ($P \leq 0.05$) in RBCs counts, Hb concentration and percentage of lymphocyte in group administrated BPA in compared with control groups,while there are non significant changes in percentage of monocyte, eosinophil and basophilFrom the results of the present study, it was concluded thatBPA leads to occurred negative results on hematological and biochemical parameters.

Keywords

Bisphenol-A-, ALT, AST, Rat.

1. Introduction

Bisphenol A (BPA) is one of the manufacturing compounds, that interfered in production different plastic compounds and polycarbonate

and become universally used in the production of paper, food and beverage containers, consumer goods, and in many other industrial applications [1]. Recently researches showed that BPA has ability to leach out of some products, include tableware, plastic lining of cans used for food, white dental fillings sealants and polycarbonate babies' bottles. The leaching was occured by exposure of the plastic to high temperatures [2]. About 93% of urine samples in the US population contain on BPA [3]. [1] BPA found in the fluid portion of many classes of vegetables such as green beans, mushrooms, mixed vegetables, peas, corn and artichokes, which take from Cans with epoxy resin linings.ALT and AST levels were significantly increased in rats orally administrated BPA at dose 50mg/kg/B.W of for four weeks [4]. AL –Mossawi [5] reported signifigant increase in ALT and AST levels at day 90 of age of female and male offspring from mothers exposed to 250 mg/kg /BW of BPA during pre and postnatal life. [5] Reported significant increases in glucose levels of male rats exposed to 50 and 250 mg/kg/B.W. of BPA during pre and postnatal stages of their life.WBCs count significantly increased in rats exposed to (250) mg/kg/B.W. of BPA [6]. BPA is estrogen-like chemical with possible similar effects to diethylstilbestrol so, in the present pre and postnatal exposure study the decrease of RBC count which resulted in decreasing Hb concentration is thought to becaused by decrease erythropoietin production either due to estrogenic activity of BPA or decrease serum testosterone level or may be resulted from an increase indestruction of red blood cells [7].

The current study was aimed to estimate harmful effects of the exposure to BPA female rats by study the toxic effect of BPA on some biochemical andblood parameters.

2. Materials and Methods

2.1. Experimental animals

The present study was conducted at the College of Veterinary Medicine – University of Karbala. Twenty four mature female rats were purchased from care center and medicinal researches in Baghdad, Iraq. They were (14) to (16) weeks old with an average body weight (200-250) gm.

The animals were clinically healthy, kept under hygienic conditions, metal cages and glassy bottles were used to avoid exposure to BPA from old polycarbonate cages. Water and feed were givenad –libitum throughout the experimental period.

Female albino rats (24) females were divided into three main groups

(8animals of each group) as follows:

1- Negative control group: which receivedorally normal saline as a vehicle (0.5) ml/kg BW.

2- Posative control group: which receivedorally corn oil as a vehicle (0.5) ml/kg BW.

3- Treatment group: which received orally BPA at dose of (250) mg/kg B.W. /day (1/20

LD50) suspended in corn oil as high dose [8]. All treatments were given using gavage needle.

At the end of the experimental period (30) days female rats' of each group were sacrificed by placing them in a closed jar containing cotton socked with chloroform anesthesia.

Blood samples were collected by heart puncture using (5) ml disposable syringe 1 ml of blood was collected in heparinized tube for measurements of hematological parameters as soon as possible.

The rest of the blood was put in plane tubes to be centrifuged at (6000) rpm for (10) minutes to obtain serum which is then transferred to Eppendorf tubes, for the estimation of biochemical parameters. All tubes were stored at (–20) oC until analyzed.

2.2. Biochemical parameters

Serum aspartate aminotransferase(AST), alanine aminotransferase (ALT) and Glucose levels were determined by using aspecial kits (SPECTRUM AST – kit, Egypt) [9].

2.3. Hematological parameters

Red blood cells (RBCs) count,Hemoglobin (Hb),White blood cells (WBCs) count and differential WBCs countwere done by using Veterinary automated hematoanalyzer (Genex Inc., Florida USA) according to manufacturer instruction.

2.4. Statistical analysis:

The data were presented as Mean ±SE and subjected to analysis of variance by using one way analysis of variance(ANOVA) Post hoc test was used LSD to specify the significant difference among means.The SPSSProgram-was used for the analysis of data [10].

3. Results

3.1. Effect of BPA on serum levels of ALT, ASTand Glucose in Mature Female Rats

A significant($p\leq0.05$) increase is noticed in serum AST, ALTandGlucose levels in female rats treated with BPA (250 mg/kg B.W) compared with control groups.

Table (1): Effect of BPA on serum levels of ALT, ASTand Glucose in mature female rats

parameters / Groups	ALT U/ml	AST U/ml	Glucose mg/dl
Normal saline group (Negative control group) (0.5ml/kg/B.W)	CD 47.71±1.04	C 80.28±1.01	BC 65.71±1.04
Corn oil group (Positive control group) (0.5ml/kg/B.W)	C 52.62±2.57	C 98.75±2.68	B 69.37±1.82

Bisphenol-A- group (Treated group) (mg/kg/B.W 250)	A 96.00±2.23	A 331.37±13.25	A 80.50±3.47

Values are mean ±SE

N=8

Different letters represent a significant difference at (p≤0. 05).

3.2. Effect of BPA on RBCs count and Hb concentration in mature female rats

Table 2 shows that exposure to BPA (250 mg / kg B.W.) produces a significant($p \le 0.05$) decrease in RBCs count and Hbconcentration-sin female rats compared with control groups.

Table (2): Effect of BPA on RBCs count and Hb concentrationin mature female rats

Parameters / Groups	RBC 10^6cell/ml×	Hb g/dl
Normal saline group (Negative control group) (0.5ml/kg/B.W)	A 6.73±0.19	A 13.71±O.42
Corn oil group (Positive control group) (0.5ml/kg/B.W)	B 5.76±0.21	A 13.25±O.45
Bisphenol-A- group (Treatment group) (mg/kg/B.W 250)	C 4.16±0.21	B 8.00±0.46

Values are mean ±SE

N=8

Different letters represent a significant difference at (p≤0. 05).

3.3. Effect of BPA onWBC countand differential count of WBC in mature female rats

The effect of exposure to (250 mg / kg B.W.) of BPA demonstrates a significant($p \le 0.05$) increasein WBCs count and the percentage of neutrophils, while the percentage of lymphocytes shows asignificant($p \le 0.05$) decreaseinBPA treated of female rats when compared with the control groups Table (3). No change is observed in the percentage of monocytes, eosinophils and basophils.

Table (3): Effect of BPA(250 mg / kg B.W.)on total anddifferential leukocyte counts in mature female rats

Parameters / Groups	WBC 10^3cell/× ml	Lymphocyte %	Monocyte %	Neutro-phil %	Eosinophil %	Basophil %
Normal saline group Negative control) (group (0.5ml/kg/B.W)	B 8.15±0.16	A 89.57±0.61	A 1.50±0.21	C 6.85±0.55	A 1.64±0.17	A 0.42±0.17
Corn oil group Positive control) (group (0.5ml/kg/B.W)	B 8.27±0.22	A 89.87±0.39	A 1.37±0.18	C 7.37±0.91	A 1.12±0.24	A 0.25±0.09
Bisphenol-A- group (Treatment group) (mg/kg/B.W 250)	A 11.66±0.33	C 72.37±1.86	A 1.25±0.09	A 24.25±1.86	A 1.50±0.16	A 0.62±0.15

Values are means ± SE

N=8

Different letters represent a significant difference at (p≤0. 05).

4. Discussion

The current study showed that female rats treated with (250 mg/kg B.W) of BPA demonstrateda significant increase in AST and ALT levels compared with control groups. These results were matched with the results obtained by [4,11,12,13,14,15,16] reported that exposure to BPA lead to changes in liver result in an increase in oxidative stress that may explain the increased levels of AST and ALT. On the other hand, there was an increase in blood glucose concentration in rats exposed to BPA (250) mg/kg/day.This result matched with [17] who showed that BPA disrupt glucose homeostasis in pregnant mice.BPA affects glucose metabolism by different mechanisms such as oxidative stress, inflammation, insulin resistance and β cell dysfunction. BPAhas also been shown to cause, hyperinsulinemia and is considered a potential diabetogenic agent [18,19, 20]. The current results showed that there was a significant decrease in the RBCs count and Hb level in female rats exposed to (250) mg/kg/BW of BPA compared with control groups and these results were in agreementwith previous studies [21, 10, 4, 22, 23, 24]. [25] reported a decrease in RBCs count and Hb concentration in rats exposed to BPA at high doses, BPA may decrease the concentration of iron in the blood or lead to shorter half life for red blood cells and their degradation as a result to changing in cell membrane permeability that make red blood cells more fragile and prone to hemolysis. These result was matched with [26] who reported anemia and significant alterations in several biochemical parameters ihn raes exposed to BPA for long time .In the present study, there was an increases in WBCs count after the exposure to 250 mg/kg/BW of BPA, which may explained on the basis of the role of BPA in induction of inflammatory conditions or may be due to increase in the percentages of neutrophils. In addition the increasing number of WBCs could be due to stress that induced by BPA and stimulation of immune system. This result is in accordance with [27].

References

[1] Brotons,J.A.; Olea-Serrano, M.F. ;Villalobos, M. ; Pedraza, V. and Olea, N.: Xenoestrogens released from lacquer coatings in food cans. Environ. Health. Perspect.., 103: 608–612, (1995).

[2] Le,H.H.; Carlson, E.M.; Chua, J.P. and Belcher, S.M.;: Bisphenol A is released from polycarbonate drinking bottles and mimics the neurotoxic actions of estrogen in developing cerebellar neurons. Toxicol. Lett. ,176: 149–156, (2008).

[3] Calafat,A.M.; kuklenyikZ, Reidy.J A.;ill, SP; EkongJ. and NeedhamL.L.: Urinary concentrations of bisphenol A and 4-nonyl phenolin a human reference population. Environ. Health. Perspect.., 3:391-395, (2005).

[4] Korkmaz, A.; Aydogan, M.; Kolankaya, D. and Barlas, N.: Influence of vitamin C on bisphenol A, nonylphenol and octyl -phenol induced oxidative damages in liver of male rats. Food Chem. Toxico.,;48: 2865- 2871,(2010).

[5] AL –Mossawi, A. H.: Physiological and reproductive activity in rats exposed to bisphenol A during different life stages. PhDThesis .College of Veterinary Medicine , Basrah University .PP.50-202,(2013).

[6] Nitschke,K.; Lomax, L.; Schuetz, D.; Hopkins, P. and Weiss, S. Bisphenol A13-week aerosol toxicity study with Fischer 344 rats (final report) EPA/OTS. Dow Chemical Company.

[7] Horiguchi, H.; Oguma, E.; Sakamoto, T; Murata, K. and Kayama, (2013): Suppression of erythropoietin induction by diethylstilbestrol in rats. ArchToxicol.,4-13, (1988).

[8] National Institute for Occupational Safety and Health (NIOSH) BisphenolA data sheet for priorized NIOSH/OSHA substances proposed for nationaltoxicology program U.S. Department of Health Education and Welfare, Public Health Service, Centre for disease control, Rockville,Maryland, (1978).

[9] Young,D.C. ; Effects of drugs on clinical laboratory tests.3rd Ed. PP: 6-12, (1990).

[10] SPSSStatistical Packages for the Social Sciences. Statistical software for windows version 13.0 Micrisoft. SPSS, Chicago, IL, USA, (2001).

[11] Yamasaki, K.; Sawaki, M.; Noda,S.; Imatanaka, N. and Takatsuki,M. Subacute oral toxicity study of ethynylestradiol and bisphenol A, based on the draft protocol for the ‘enhanced OECD test guideline no. 407’. Arch Toxicology., 76 (2) : 65–74, (2002a).

[12] Yamasaki,K.; Takeyoshi, M.; Noda, S. and Takatsuki, M. Changes of serum α 2μ-globulin in the subacute oral toxicity of ethynylestradiol and bisphenol A based on the draft protocol for the ‘Enhanced OECD Test Guideline No. 407’. Toxicology..,176:101–112, (2002b).

[13] Hassan,Z.K.; Elobeid, M.A.; Virk, P.; Omer, S.A.; ElAmin, M.; Daghestani, M.H. and AlOlayan, E.M. Bisphenol A induces hepatotoxicity through oxidative stress in rat model. Oxidative Med Cell. Long., I.D.:194829,(2012).

[14] Mourad,I.M. and Khadrawy, Y.A. The sensetivity

of liver, kidney and testis of rats to oxidative stress induced by different doses of Bisphenol A. Intern. J. Life Sci. Pharma col. Rev. .,2:19-28,(2012).

[15] Sangai,N.P. and Verma, R.J. Quercetin ameliorates bisphenol A induced toxicity in mice: Acta Polo Pharmac Drug Res., 69 (3) 557-563,(2012).

[16] Moon,M.K; Kim, M.J.; Jung, I.K; Koo, Y.D.;Ann, H.Y.; Lee, K.J.and Kim, S.H.Bisphenol A impairs mitochondrial function in the liver at doses below the no observed adverse effect level. J. Korean Med. Sci.27: 644-652,(2012).

[17] Alonso-Magdalena,P.; Ropero, A.B.; Soriano, S.; Quesada, I. and Nadal, A. Bisphenol-A: a new diabetogenic factor Hormones (Athens) 9:118–126,(2010).

[18] Adachi,T.; Yasuda, K.; Mori, C.; Yoshinaga, M.; Aoki, N.; Tsujimoto, G. and Tsuda, K. Promoting insulin secretion in pancreatic islets by means of bisphenol A and nonylphenol via intracellular estrogen receptors. Food Chem. Toxicol., 43: 713–719,(2005).

[19] Alonso-Magdalena,P.; Morimoto, S.; Ripoll, C.; Fuentes, E. and Nadal, A. The estrogenic effect of bisphenol A disrupts pancreatic beta-cell function in vivo and induces insulin resistance. Environ. Health Perspect.,114: 106–112,(2006).

[20] Jayashree,S.; Indumathi, D.; Akilavalli, N.; Sathish, S.; Selvaraj, J; and Balasubramanian, K. Effect of Bisphenol-A on insulin signal transduction and glucose oxidation in liver of adult male albino rat. Environ. Toxicol .and Pharmacol., 35 : 300–310,(2013).

[21] Furukawa,F.; Nishikawa, A.; Mitsui, M.; Sato, M.; Suzuki, J.; Imazawa, T.and Takahashi, M.: A 13-week subchronic toxicity study of Bisphenol A in B6C3F1 Mice. Bullet Nat Ins Health Sci., 112: 89-96,(1994).

[22] Umano,T.; Miyata, K·; Minobe, Y·and Yamasaki, K.: Enhanced OECD TG 407 in detection of endocrine-mediated effects of 4, 4_-(octahydro-4,7-methano-5H-inden-5-ylidene)bisphenol.Arch Toxicol., 84:175–182,(2010).

[23] Ulutaş,O.K.; Yıldız, N.; Durmaz, E.; Ahbab, M.A.; Barlas, N. and Çok, İ.: An in vivo assessment of the genotoxic potential of bisphenol A and 4-tert-octylphenol in rats. Arch Toxicol., 85:995–1001,(2011).

[24] Yamasaki,K. and Okudab, H.: Comparison of endocrine-mediated effectsof two bisphenol A related compounds, 2,2-bis(4 cyanatophyenyl) propane and 4,4_ - cyclohexylidenebisphenol, based on subacute oral toxicity studies using rats. Toxicol. Lett., 208: 162– 167,(2012).

[25] Thomas,P.; Bally, M.and Neff, J.M.: Ascorbic acid status of mullet,Mugil cephlusLinn., exposed to cadmium. J. Fish. Biol.. 20: 183 – 196,(1982).

[26] Ahmed .W.M.;Moselhy ,W.A and Nabil, T.M.: Bisphenol a toxicity in adult male rats hematological, biochemical and histopatyhological approach. Glob. Vrterinaria 14(2):228-238,(2015).

[27] Adedapo,A.;A and Aiyelotan, O.: Effect of chronic administration of indomethacin on haematological parameters in rats. Afr J Biomed Res., 4:159-160,(2001).