Structural and D.C. conductivity investigation of the ternary alloy System a-Al_XGa_{1-x} As:H films prepared by new deposition method

H. Kh. Al- Lamy, M.F. Alias. M. N. Makadsi

Department of Physics, College of Science, University of Baghdad

Abstract

In this paper Al_x Ga_{1-x} As:H films have been prepared by using new deposition method based on combination of flash-thermal evaporation technique. The thickness of our samples was about 300nm. The Al concentration was altered within the $0 \le x \le 40$.

The results of X- ray diffraction analysis (XRD) confirmed the amorphous structure of all Al_XGa_{1-x} As:H films with $x \le 40$ and annealing temperature (T_a)<200°C. the temperature dependence of the DC conductivity GDC with various Al content has been measured for Al_XGa_{1-x} As:H films.

We have found that the thermal activation energy E_a depends of Al content and Ta, thus the value of Ea were approximately equal to half the value of optical gap.

Key words
ternary alloy System
a-Al_XGa_{1-x} As:H films

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دراسة التركيب البلوري والتوصيلية المستمرة للمركب Al_XGa_{1-x} As:H المحضر بطريقة ترسيب جديدة

حسين خزعل رشيد ميسون فيصل الياس متي ناصر مقادسي

قسم الفيزياء كلية العلوم ، جامعة بغداد

الخلاصة

تم في هذا البحث استخدام طريقة جديدة في تحضير اغشية Al_XGa_{1-x} As:H بترسيب مزدوج حراري وميضي لاغشية بنسبة x=40 و (T_a)<200 لوحظ اعتماد التوصيلية المستمر على نسبة Al كذلك وجد اعتماد طاقة التنشيط على نسبة Al ودرجة حرارة التلدين. وجد ان قيمة فجوة الطاقة مساوية الى ضعف طاقة التنشيط تقريبا.

Introduction

Ternary alloy systems Al_XGa_{1-x} A are one of the must useful materials for opto electronics and microstructure dçvices such as, high efficiency Al_XGa_{1-x}A/GaAs, double hetrojunction and high speed digital applications [1,2]. The majority of previous work have been devoted to c-Al_xGa_{1-x}As prepared by various technicals: MO- CVD, LPE, MBE [3,4]. Selected band gaps of ternary 35 alloyes can be obtained by altering the composition, these material are now widely used in optoelectronics devices.

In this study we have investigated the structural and the σDc of Al_xGa_{1-x}As:H films as a function of composition and annealing temperature, on the other hand fewer studies have been devoted to amorphous ternary III-V compounds and as far as we know, no one has studies Al_XGa_{1-x} As:H films in the amorphous form by using this technique.

Experimental details

The Al_XGa_{1-x} A:H films were prepared by using new deposition method based on combination of flash, thermal evaporation, in high vacuum coating unit (BAE 370), with an arrangement for flash evaporation. The details of the deposition system are given in ref. [4] the composition of the films was altered by varying the weight of Al amount was deposited by thermal evaporation and determined by EDS analysis. The films were deposited simultaneously on various ultrasonically cleaned substrates [4]. The hydrogenation of $Al_XGa_{1-x}As$:H films has been performed in situ by hydrogen plasma under pressure nearly P_{H2} = 8 x 10^{-2}.mbar The structure of films study by XRD for different T_a the σDc was measured by two - probe technique using a keithly 116 digital electrometer. Al electrodes 1cm long and 0.5 cm apart were evaporated in a coplanar configuration on to the samples.

Results and Discussion

1. Microstructure of Al_XGa_{1-x} A:H films

The XRD analysis of $Al_XGa_{1-x}As$:H films exhibited amorphous structure for all samples with x ≤ 40 and T_a Al_XGa_{1-x}A**s** >200 °C. but for samples aimelid with T_a> 200 °C three characteristics diffraction peeks appeared corresponding to the (111), (220), and (311) reflection of polycrystafline $Al_XGa_{1-x}As$:H films as in fig (1), this transition in structure is in agreement with previous work [7,8]. These results is a similar to the case of a- Ge films, this confirms that these compounds retain there tetrahedral coordination on the average [9].

2. Dark of $Al_xGa_{1-x}As$:H films

The temperature dependence of σDc $Al_xGa_{1-x}As$:H films with various Al content is almost characterized by tow stages of conductivity mechanism in the temperature range (25-300)°C. fig. (2) shows the variation of E_a with Al content. The first stage (25-100)°C. the value of E_a increases from 0.6 EV for x = 0 to 0.81 EV for x = 30. While for x >30 the value of E_a decreases in contrast with c-$Al_xGa_{1-x}As$[10].Our interoperation of this behavior is that the addition of Al is substantially incorporated in place of Ga atoms and most of bond between Ga- As or Al- As are expected while for x >30 each Al atom will not necessarily substituted for Ga atom. Therefore like atom or wrong bonds are expected [11].

The temperature dependence of σDc of annelid $Al_xGa_{1-x}As$:H films indicated to the variation of E_a With T_e as shown in fig (3). From this figure we can see that the value of E_a increases from E_a 0.79 EV for T_a =25 °C to E_a = 0.97 for T_a 25 0°C. for samples annelid with T_a > 300°C the value of E_a decreases toward unhydrogenated samples. The is attributed to the evaluation hydrogen in corporation in the films. [11]

Conclusions

XRD analysis shows that the films as deposited are amorphous for all Al content. However, the as deposited films and annelid at T_a> 200°C becomes polycrystalline. The value of E_a increases with Al content within the range 0 ≥ x ≤ 30, while decreases for x >30, such behavior may be associated with Al-related defect states in the gap, hydrogen incorporation eliminating the dangling bonds from the gap.

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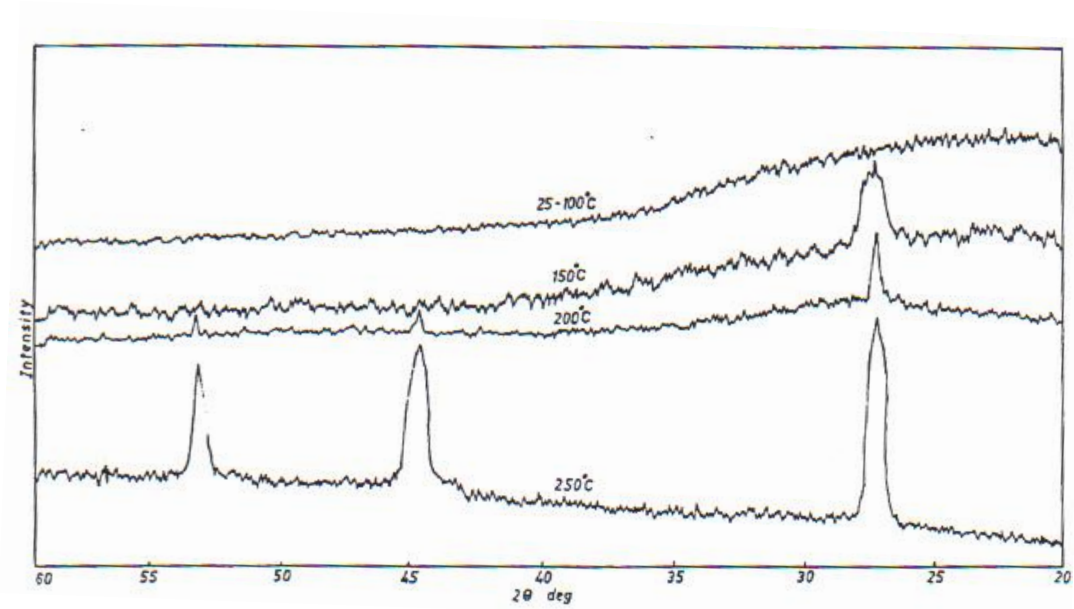
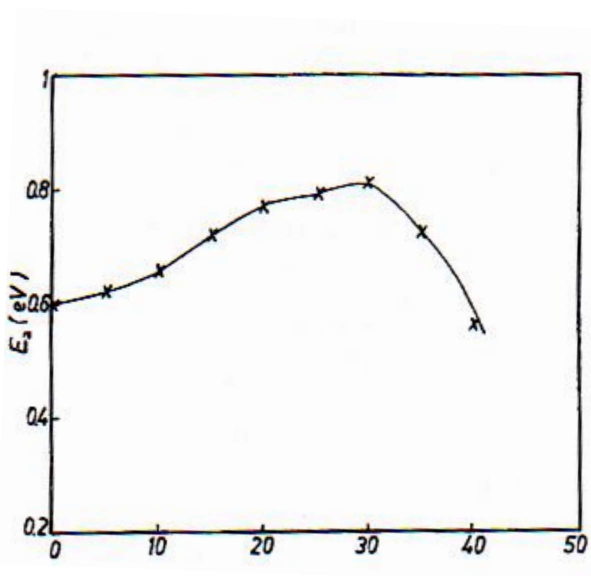
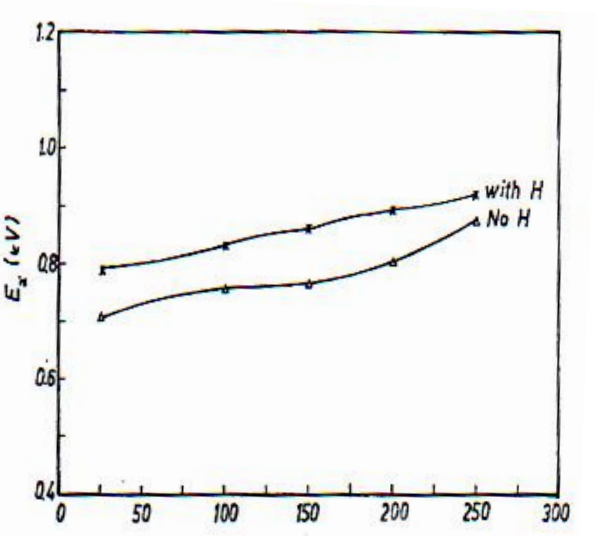


Fig. (1) XRD patterns of a-A1$_x$ Ga$_{1-x}$ As: H films with different annealing temperature



Al%

Fig (2) Dependence of activation energy on the Al % for a-Al$_x$ Ga$_{1-x}$ As: H films



Annealing temperatures ^oC

Fig (3) Dependence of activation energy on the T_a of a-A1$_{30}$Ga$_{70}$ As: H films