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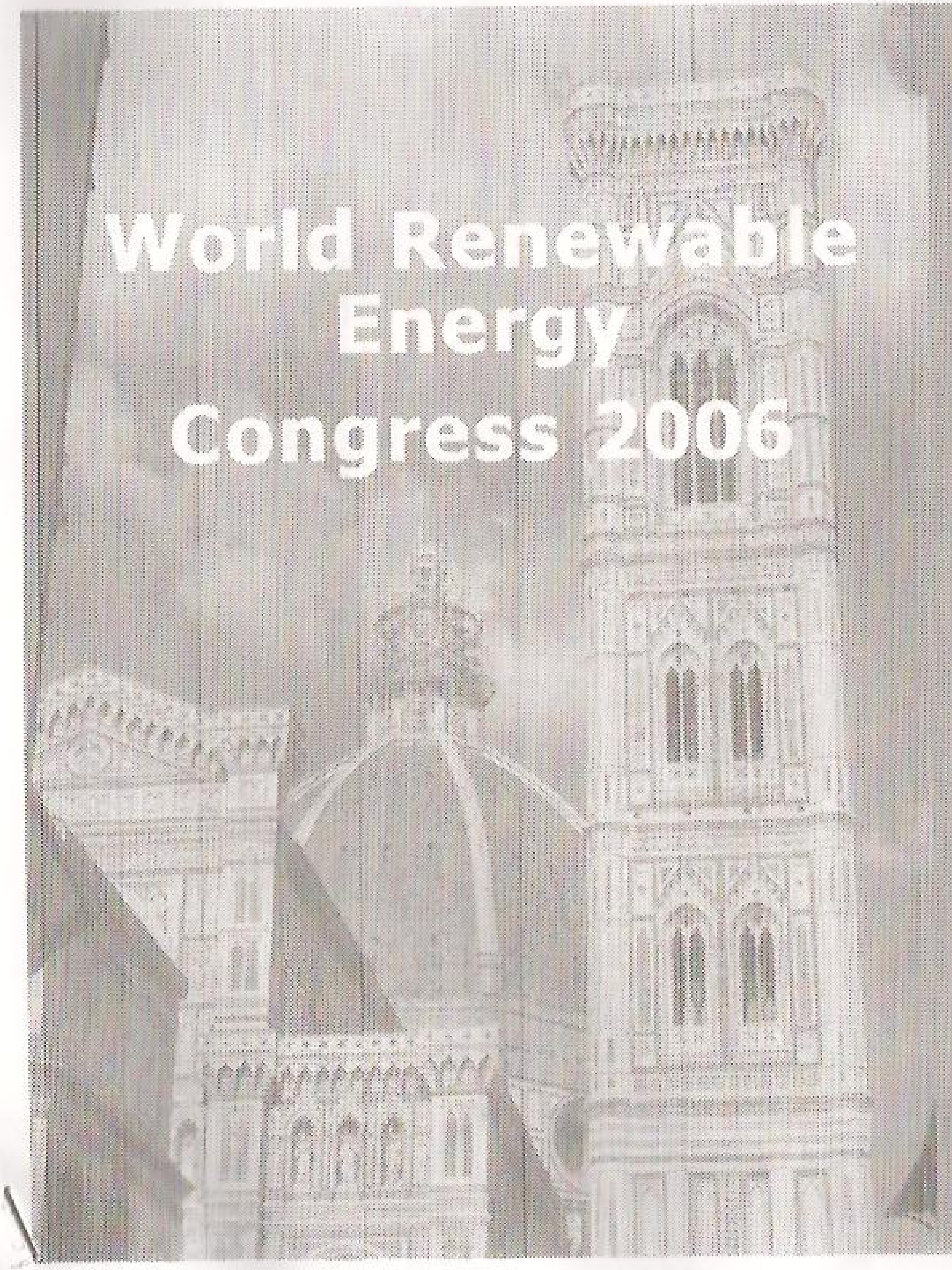

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The high Energy Region of the Absorption Edge of a-Si:H , An analytic study

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Abstract

In this work , the authors used the experimental results due to Jackson et al for the density of states convolution integral (J(E)) vs. photon energy E for GD a-Si:H films in the energy range (1.6-3.7)eV . We plotted the square and the cubic roots of J(E) as a function of E , the square root plot $J^{1/2}(E)$ exhibited a fairly linear behaviour in the energy range (~1.8-3.3)eV . Because J(E) depends only on the density of states distributions near the band edges of the valence and conduction bands , in contrast to the imaginary part of the dielectric function $\in_2(E)$ which depends also on the transition matrix element , we concluded that the density of states distribution near each band edge could be approximated by a parabolic law behaviour i.e $N(E)\alpha E^{1/2}$. As Jackson et al found the electric dipole matrix element squared $R^2(E)$ is constant in the energy range of for GD a-Si:H films , we conclude that the theoretical model due to Cody ($N(E)\alpha E^{1/2}$, $R^2(E)$ = constant) is in accord the above experimental findings .

Thus we recommend the plot due to Cody ($\in_2^{1/2}$ $vs.E$) as the most suitable plot to analyze $\in_2$ - data of the high absorption region of the optical absorption edge of high quality GD a-Si:H films , and Cody's theoretical model as the proper entry towards a possible future solution of the optical gap problem in this material at least .

Introduction

It is well known , that the magnitude of the forbidden gap and its relation to the optical absorption edge is still a mystery in amorphous semiconductors [1] . Fundamentally , this is because that the optical absorption depends not on a convolution of the conduction band (CB) and valence band (VB) density of states but also on the transition matrix element [2] .

In order to possible solve this dilemma , two independent measurements of the density of states distributions close to both edges of the valence and conduction bands , and the optical absorption spectrum of the high photon energy region ($\alpha \geq 10^4 cm^{-1}$) where α is the absorption coefficient of the absorption edge on the same samples or at least prepared at the same run , should be performed .

Because of the difficulties in achieving such kind of a project , it is seldom found in literature , except may be is the very important and it might be considered unique work of Jackson et al [2] about 20 years ago , where they determined the energy dependence of the optical matrix element of GD- a-Si:H films using independent measurements results of the density of states and the ϵ_2 spectra . (where ϵ_2 is the imaginary part of the dielectric function) in the energy range (~0.6-6eV) .

We think that the correct implications of this important and fairly accurate work are not well established in the scientific society , except for an important note stated by Cody some years ago [3] .

For this purpose , and on behalf of Jackson et al important work , the authors here studied it in more details , to make use of its full implications , in the hope of catching the right thread towards a possible solution of the optical gap problem in the near future at least for high quality GD a-Si:H films which are now very important optoelectronic materials .

Theory

Following Jackson et al [2] , the imaginary part of the dielectric function an amorphous structure and unpolarized light is given by :

$$\epsilon_2(E) = \frac{(2\pi e)^2}{3\rho A} R^2(E) \int N_V(E'+E)dE' ------------ (1)$$

Where E is the photon energy , E' is the state energy , e is the electron charge , $N_V(E')[N_C(E')]$ is the valence (conduction) band density of states , ρ_A is the atomic density , and $R^2(E)$ is the square of the normalized (with respect of the crystal) average dipole matrix element .

If for simplicity , we assume that the density of states distribution near the mobility edge of the valence (conduction) band is a simple power law $(N(E')\alpha E'^m$ i.e symmetrical DOS (an assumption which is usually not easy to justify in amorphous materials) we can define a theoretical optical energy gap E_o as seen in the following resulting expression [1]

$$E^q \epsilon_2(E) = K_{th}(E - E_o)^r -------- (2)$$

Where : K_{th} is a theoretical prefactor , q is an index indicating the simple power dependence of the dipole matrix element (if possible) $(R^2 \alpha E^{-q}),(r = 2m+1)$ and E_o exactly defined if the limits of the density of states convolution integral in eq.1 is equal to the zeros of the two functions inside it [4] .

Because the dependence of $\epsilon_2(E)$ on both the values of q and r , there is no unique way to define the exact value of the optical gap E_o only if an independent measurement of the density of states near the mobility edge is accomplished for the sample under study which is a very hard task . According to our knowledge , only Jackson et al [2] succeeded in doing for GD a-Si:H samples , the energy dependence of $R^2(E)$ in the energy range (~0.6-5.9)eVwas determined from combined measurements of the optical absorption and the density of states distribution in the appropriate energy range for GD a-Si:H samples prepared by the above authors .

They found that the dipole matrix element , $R^2(E)$, the constant within the errors of their experiment for energy up to 3.4eV and decreases roughly as E^{-5} above this energy .

This is in partial accordance with the assumption of Cody [1] that the dipole matrix element is constant (to ~ 20eV) and not the momentum matrix element $P^2(E)$ as proposed previously by Tauc [5] .

In accord with to equation (2) ,with q=0 as the above mentioned experimental results indicated , Cody [1] found that this data of $\in_2^{1/2}$ for a-SiH$_X$ (x=0.09) as a function of E fits excellently to the linear equation [$\in_2^{1/2}$ = 3.06 (E-1.64)] in the board energy range (1.6-3)eV , this means that r should equal to 2 in eqn. 2 in order to conform with the experimental results of Jackson etal [i.e q=0] , which means that $N(E')$ could be well approximated to a parabolic dependence on the state energy $E'[i.e N(E')\alpha E'^{1/2}]$.

In order to check for that , we found the density of states convolution integral data announced by Jackson et al for GD a-Si:H in the energy range (0.6-5.9)eV most beneficial as we shall see below .

Results and Discussion

Fig.1 shows the main Jackson et al results [2] for $\in_2(E)$, J(E) (the density of states integral) and $R^2(E)$ in the photon energy range[~1.5-5.9]eV.

We have replotted Jackson et al J(E) data as $J^{1/2}(E)$ and $J^{1/3}(E)$ as a function of E in the wide range (1.6 – 3.7) eV as shown in fig . 2 , which covers the high energy region of the optical absorption edge of a-Si:H in full .

We note and conclude the following from these plots .

(1)The function $J^{1/2}(E)$ extracted from experimental J(E) data highly correlates to a linear behaviour in the range (~1.78-3.25)eV a range which covers the high energy region of the absorption edge , and because J(E) does not depend on $R^2(E)$ and they depends only the density of state distributions of the valence and conduction bands (in contrast to $\alpha(E)$ or $\in_2(E)$ which depend on both) therefore according to eq.2 :

$$J(E)\alpha(E-E_o)^{2m+1} \text{ ----------(3)}$$

As r=2m+1 = 2 according to eq.2 then m should equal to ½ , which means that we can approximate the density of state distributions of the valence and conduction bands to a parabolic behaviour (i.e $N(E)\alpha E^{1/2}$) . We note from fig.2 that $J^{1/3}(E)$ data does not behave linearly with E at all excluding the narrow energy range (~1.78-2) eV .

(2) The extrapolation of the straight line fit to $J^{1/2}(E)$ to the energy axis (J=0) gives us Eo~1.68 eV , while the extrapolation of the short $J^{1/3}(E)$ line is ~ 1.57 eV .

(3) We conclude the following from the above important notions :

a) The density of states distributions of the valence and conduction bands edges of Jackson etal GD a-Si:H films (which are electronic grads films) can be approximated by a parabolic function i.e with m=1/2 in eq.2 (r=2m+1) , this is in accordance with the original assumption of Tauc [5] that $N(E)\alpha E^{1/2}$ near the band edges of amorphous semiconductors similar to (at least) crystal semiconductors but for the special case of electronic grade GD a-Si:H films of least .

b) As Eo~1.68 eV for $J^{1/2}(E)$ plot , combined with experimental finding of Jackson et al that $R^2(E)$ is constant in the energy range interest and that $N(E)\alpha E^{1/2}$ near the band edges of valence and conduction bands of Jackson et al films , and noting that the $\epsilon_2^{1/2}(E)$ vs. E plot for Jackson et al films is linear in the energy range of interest (~1.6-3)eV with extrapolation to E-axis giving E_o~ 1.64 eV as given by Jackson et al in their paper which is close to the 1.68 eV for the $J^{1/2}(E)$ extrapolation . We conclude that the most proper theoretical model that should be adopted as the correct start towards a possible understanding of the high energy region of the absorption edge problem in a-Si:H , is the one that is due to Cody [1] who proposed $R^2(E)$ to be constant and $N(E)\alpha E^{1/2}$ near the band edges for a-Si:H films , excluding Tauc model which is not appropriate for GD a-Si:H films because he proposed that the momentum matrix P(E) to be constant and not the dipole matrix element in contradiction to the experimental finding of Jackson etal , and the Klazes et al [6] assumptions for a-Si:H films of $N(E)\alpha E^{1/2}$ and $P^2(E)$ is constant .

Stated in another and more practical way $E\epsilon_2^{1/2}$(or $(\alpha/E)^{1/2}$) plot attributed to Cody [1] should be adopted for a-Si:H films and not $(E^2\epsilon_2)^{1/2}$ (or $(\alpha/E)^{1/2}$) attributed to Tauc [5] or $(E^2\epsilon_2)^{1/3}$ (or $(\alpha/E)^{1/3}$) attributed to Klazes et al [6] because the last two does not conform with the experimental findings of Jackson et al for GD a-Si:H at least .
At the end , we think that our conclusions could be considered conclusive for the correct plot to adopt for $\epsilon_2$or α data of good energy gap problem in this material at least is automatically solved , and a correct physical meaning for E_{opt} defined as the extrapolation of $\epsilon_2^{1/2}$ plot to the E-axis , should be searched for . Our attempts toward a possible solution of this problem will be published later .

References

[1] Cody G.D , in"Semiconductors and Semimetals" , Vol.21 , Part B , ed. J.I Pankove , Academic press (1984) , p.11 .

[2] Jackson W.Kelso S.M. , Tsai C.C. , Allen J.W. , and Oh S.-J. , Phys. Rev. B31 , 5187 (1985) .

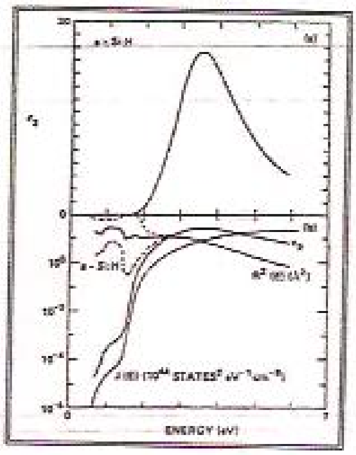
[3] Cody G.D , J. Non-Crystalline solids 141(1992) .

[4] Davis E.A. , and Mott N.F. , Phil M ag. , 22,903(1970) .

[5] Tauc J. , in Optical properties of solids" , ed. F. Abeles , North – Holland (1972) , p.227 .
[6] Klazes R.H. , Van der Broek M.H.L.M. , Bezemer J. , and Radelaar S. , Phil Mag. B4 , 5 , 377 , (1982) .

Figure Captions

(1) Figure (1) : Jackson etal results , for GD a-Si:H [2] (a) ϵ_2 *vs.E* on a linear plot . (b) ϵ_2 , J , and R^2 vs.E on a semi logarithmic plot .
(2) Figure (2) : $J^{1/2}$ and $J^{1/3}$ vs.E plotted using Jackson etal J(E) data [2] in the energy range (1.6-3.7)eV .



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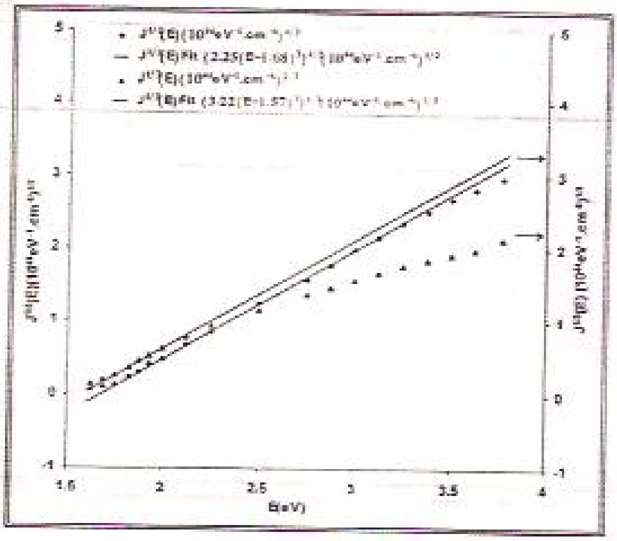

Figure (2) : $J^{1/2}$ and $J^{1/3}$ vs.E plotted using Jackson etal J(E) data [2] in the energy range (1.6-3.)eV .