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Effect of Ionizing Radiation on Optical Properties Hydrogenated Amorphous Silicon thin film Alloy Si

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Abstract

Analyzed by optical properties of hydrogenated amorphous silicon thin films a-Si:H. Optical band gap width and other settings for the a-nk-Si:H and its alloys depend not only on the content of hydrogen, but also on other parameters: substrate temperature, sedimentation rate, annealing temperature, composition, hydrogen partial pressure and the structure of the films. For amorphous and nano crystalline alloys and-nk-Si: H.

Keywords: Optical properties thin films; Hydrogenated silicon; Amorphous silicon thin films

Consider the view of optical absorption edge of conductivity σ(ω), for thin films:

$$\sigma(\omega)=\frac{2\pi e^2\hbar^2\Omega}{m^2}\int\frac{N(E)N(E+\hbar\omega)|D|^2}{\hbar\omega}dE, \quad (1)$$

Where is Ω–sample volume and D–the matrix element of the derivative operator $\frac{\partial}{\partial x}$. For the appropriate ratio, get that matrix D for transitions between States of different zones and for transitions between not localized States is as follows:

$$D=\pi\left(\frac{a}{\Omega}\right)\frac{1}{2},$$

a-the average value of the inter atomic distance. The value of D for localized wave functions, offset by a size multiplier between atomic distances rationing [1-4]. So for zone transitions are:

$$\alpha(\omega)=\frac{8\pi^4e^2\hbar^2a}{n_0cm^2}\int\frac{N_V(E)N_C(E+\hbar\omega)}{\hbar\omega}dE, \quad (2)$$

where the integral shows energy between Valence zone and zone of conductivity. In the equation (2),

$$\frac{8\pi^4e^2\hbar^2a}{n_0cm^2}C_0=const.$$

Let the density of States near the conduction band and valence band around, it seems as:

$$\begin{aligned}&N_C(E)=C_1\left(E-E_A\right)^S;0\le s\le1,\\&N_V(E)=C_2\left(E_B-E\right)^P;0\le p\le1,\\&N_C(E)=(E+\hbar\omega)=C_1\left(E+\hbar\omega-E_A\right)^S.\end{aligned} \quad (3)$$

Based on the above ratios, equation (1) can be written in the following form:

$$\alpha(\omega)=C_0\int\frac{C_2\left(E_B-E\right)^PC_1\left(E+\hbar\omega-E_A\right)^S}{\hbar\omega}dE. \quad (4)$$

Hence, we have that:

$$\alpha(\omega)=\frac{C_0C_1C_2}{\hbar\omega}\int\left(E_B-E\right)^p\left(E+\hbar\omega-E_A\right)^SdE. \quad (5)$$

We introduce the notation: $y=\frac{E_A-\hbar\omega-E}{E_A-\hbar\omega-E_B}$, taking into account that $E_0=E_A-E_B$,

get:

$$\begin{aligned}&\left(E_A-\hbar\omega\right)-E=\left(E_0-\hbar\omega\right)y\\&E=\left(E_A-\hbar\omega\right)-\left(E_0-\hbar\omega\right)y\end{aligned},$$

$$\begin{cases}E=\left(E_A-\hbar\omega\right)+\left(\hbar\omega-E_0\right)y,\\dE=\left(\hbar\omega-E_0\right)dy\end{cases}.$$

If you substitute the values into the equation (5), then we get the following ratio:

$$\begin{aligned}&E_B-E=E_B-E_A+\hbar\omega-\left(\hbar\omega-E_0\right)y=\left(\hbar\omega-E_0\right)-\left(\hbar\omega-E_0\right)y=\left(\hbar\omega-E_0\right)(1-y)\\&E+\hbar\omega-E_A=\left(E\ \ -\hbar\omega\right)+\left(\hbar\omega-E_0\right)y+\left(\hbar\omega-E_A\right)=\left(\hbar\omega-E_0\right)y.\end{aligned} \quad (6)$$

Based on equation (6) you can write:

$$\alpha(\omega)=\frac{C_0C_1C_2}{\hbar\omega}\int\left(\hbar\omega-E_0\right)^p(1-y)^p\left(\hbar\omega-E_0\right)y^5\left(\hbar\omega-E_0\right)dy$$

Or

$$\alpha(\omega)=\frac{C_0C_1C_2}{\hbar\omega}\int(1-y)^py^S\left(\hbar\omega-E_0\right)^{S+P+1}dy. \quad (7)$$

Therefore $C_0C_1C_2$= const.

$$\alpha(\omega)=const\int(1-y)^py^S\frac{\left(\hbar\omega-E_0\right)^{S+P+1}}{\hbar\omega}dy. \quad (8)$$

For simplicity, you can write:

$$\alpha(\omega)=C_0C_1C_2F(p,s)\frac{\left(\hbar\omega-E_0\right)^{S+P+1}}{\hbar\omega}. \quad (9)$$

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If $p = s = \frac{1}{2}$, then:

$$\alpha(\omega) = C_0 C_1 C_2 F\left(\frac{1}{2},\frac{1}{2}\right)\frac{\left(\hbar\omega - E_0\right)^2}{\hbar\omega}, \quad (10)$$

Here,

$$C_0 C_1 C_2 F\left(\frac{1}{2},\frac{1}{2}\right) = const.$$

So get that

$$\alpha(\omega) = \frac{const\left(\hbar\omega - E_0\right)^2}{\hbar\omega}. \quad (11)$$

The results coincide with the literary data [1].

Means for amorphous, nanocrystalline films, forbidden zone width can be determined by using the equation (1). Note that the option E0, in most films, describes the width of the forbidden zone.

Based on this model, we come to the conclusion that the tails of the valence band and conduction zones overlap, the overlap zones donor and Acceptor levels are associated with the same defects. In the area of overlapping conditions, position the Fermi level is constant. Another feature of the principle of this model is the existence of a "mobility" edges in the tails of the zones. These edges are identified with the previously entered mobility. Mott, critical energies that define localized State of non-localized, so this model is often referred to as model Motta-Cohen-Frice-Ovshinskiy. The difference between the energies of the edges in the mobility in the tails of the zones area of conduction and Valence zone indicates a width for the "forbidden zone for mobility" (slit for movement). Based on this model, it is assumed that the zone deep acceptors, partially filled with electrons created the weaker donor area. Donors and acceptors can change roles. Mott suggested that if these States arise from defect, for example, free connection, they can act as donors and as acceptors, and conditions of a single or double fill these conditions lead to the formation of two zones, separated by appropriate energy Hubbard.

Conclusion

Optical band gap width and other settings for the *a*-nk-Si:H and its alloys depend not only on the content of hydrogen, but also on other parameters: substrate temperature, sedimentation rate, annealing temperature, composition, hydrogen partial pressure and the structure of the films. For amorphous and Nano crystalline alloys (and-nk-Si: H), optical band gap determines the width of the data acquisition, which describes the ratio of eqn. (1). In this case eqn. (1) is as follows:

$$\alpha\hbar\omega = B\left(\hbar\omega - E_0\right)^2. \quad (12)$$

The value of the B for films *a*-$Si_{1-x}Ge_x$:H is 319÷547 $eV^{-1}cm^{½}$

All films of the optical band gap width are described by the eqn. (12).

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