

THE VOLT-AMPERE CHARACTERISTICS OF AMORPHOUS SOLID SOLUTIONS OF Se-S SYSTEM

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The volt-ampere characteristics (VAC) of film amorphous solid solutions of Se-S system, obtained by the method of hot wall are investigated. The current for all investigated samples increases at the change of voltage value V_x - transition from ohmic region into quadratic one, i.e. the injected current appears in the investigated samples. The increase of concentrations of local states in Se-S system samples with the increase of sulfur content is explained by structural differences of the investigated samples.

The glasses are called chalcogenide ones, in the composition of which Se, S, Te [1] are included. The systems on Se, S, Te are widely used in the additions and the experiments besides the pure ones. The glasses of more complex composition [2-4] are widely used. The chalcogenide and chalcogene glasses are used in the electron diffraction investigation (xerography), for the recording of optical information, in electric changers and storage devices [5-8].

Selenium, sulfur and solid solutions on their base are close to chalcogenide glasses on their physical properties. However, as it is known Se is semiconductor, whereas, S is good isolator. Consequently, this system promotes the interest peculiarity in the change from semiconductor up to isolator.

The homogenous solutions at the crystallization of which the series of solid solution precipitates form in melted state between sulfur and selenium. Taking into consideration, that there are many general things in sulfur and selenium behavior, it is possible to propose, that they are able to form the mixed molecules of SSe type [9].

Though *Se* and *Te* have properties, which are analogical to chalcogenide properties [10], they contain the structural units with molecular properties and are considered separately.

The structural model of binary system presents itself the continuous grid, in which the coordination "rule 8-N" for both components at any their relation is carried out. The hetero- and homeopolar bonds are possible between atoms. The hexagonal crystalline Se consists of helical chains, set parallel each other. The chemical bond inside chains has the covalent character and it is very strong, but the bond between the chains is the weak one of Van der Waals type. In liquid phase it is possible to consider, that chains are oriented occasionally. At quick alloy cooling the viscosity becomes very high before chains have time to redirect and glassy state appears [11].

The Te addition into selenium liquid solution leads to chain shorting, as Se-Te bond is weaker, than Se-Se one and crystallization at cooling becomes easier. At S addition into melt, it can be said, that the vice versa takes place, as Se-S bond is stronger, than Se-Se one. The amorphous selenium presents itself the mixture of molecules (closed ringers) and polymer chains. S, Se and Te have the coordination number, which is equal to 2. The average mole energies in S, Se and Te series decrease and melting point and density increase. This shows that the more bonds are in the chain, the less bonds between them [12].

Nowadays it is established, that it is possible to directedly change the electron properties of chalcogene and

chalcogenide glassy semiconductors by the change of chemical composition and also by impurity introductions. Moreover, the change of concentration of charged defect centers (U^+) in them takes place and thus it is possible to manage by their electric, optic and photoelectric properties, that it is very important for practical use [11].

The given work contains the investigation results of volt-ampere characteristics of film amorphous samples of $Se_{100-x}S_x$ ($x=5; 30; 40$) system.

The selenium by B_5 purification and pure rod sulfur, suspended with accuracy up to 0,0001g are taken for the obtaining of solid solutions selenium-sulfur. The vibration method is used for better melt homogenization. The ampoules during 3 hours are treated by shaking at temperature 280°C, i.e. on 60°C higher the selenium melting point.

The films by width 3 mcm are obtained by thermal spraying in vacuum, by the method of hot wall, on the substrates from cover glass. Te, marked by evaporation in vacuum is used in the capacity of injected contact. Al is used in the capacity of general contact [13].

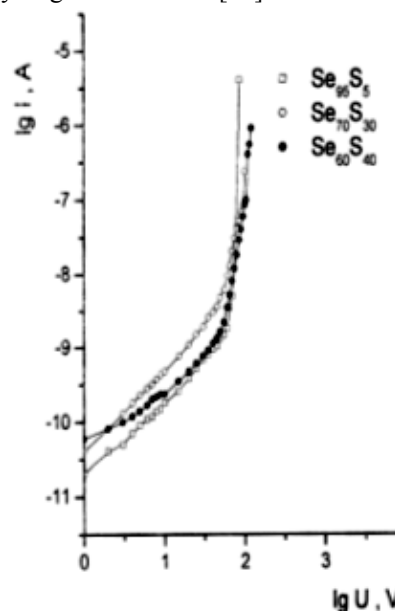


Fig.

The measurement results of VAC of investigated samples are presented on the figure.

As it is seen from the figure, VACs of investigated samples consist of ohmic and quadratic regions. The current of injected electrons, limited by recombination, begins to dominate under the current of thermally excited holes.

The voltage of V_x transition from Ohm law up to “trap” quadratic law [14] in $1/\theta$ times exceeds the transition voltage for without-trap case, defined by the formula

$$V_x \approx \frac{en_0L^2}{\varepsilon} \quad (1)$$

If the concentration of free electrons doubles in the result of injection, then expression for the concentration of nonequilibrium electrons, picked on fin traps, has the form n/θ , moreover

$$V_x \approx \frac{en_0L^2}{\theta\varepsilon} \quad (2)$$

The current for the sample of $Se_{95}S_5$ composition strongly increases at the voltage transition of V_x -transition from ohmic region into “trap” quadratic one. The current

increase from the voltage is observed for the samples of $Se_{70}S_{30}$, $Se_{60}S_{40}$ compositions, i.e. the injected current appears in the investigated samples.

It is observed, that inclinations from ohmic going in VAC for $Se_{95}S_5$, $Se_{70}S_{30}$, $Se_{60}S_{40}$ samples take place at the values $V_x \approx 60, 25; 54,95; 48, 97V$, correspondingly. By this values the concentrations of local states, which are equal for given compositions: $4,75 \times 10^{19}; 3,85 \times 10^{19}; 3,25 \times 10^{19} \text{ cm}^{-3}$ are calculated on the formula, correspondingly [14].

$$N_t = 1,1 \times 10^6 \varepsilon \frac{V_x}{L^2} \quad (3)$$

Thus, the increase of local state concentrations in the samples of Se-S system with increase of sulfur content can be explained by the structural differentiations of the investigated samples.

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| <p>[1] <i>A.Meden, M. Sho.</i> Fizika i promeniye amorfnykh poluprovodnikov. “Mir”, M., 1991, (In Russian).</p> <p>[2] <i>K.Shimakawa, A.Kolobov.</i> Adv.Phys. 1995, 44, 537.</p> <p>[3] <i>K.L.Bhatia, G.Partasarathy. E.S.P.Gopal.</i> J. Non-Cryst. Sol. 1985, 69, 189.</p> <p>[4] <i>I.A. Chaban.</i> FTT, 2007, t.49, v.3, s.405. (In Russian).</p> <p>[5] <i>L.A.Wahab, M.B.El-Den, M.S.Youssef.</i> Egypt. J. Sol., 2000, v.23, No.1, 71.</p> <p>[6] <i>S.R.Ovshinsky.</i> Phys. Rev. Letters, 1988, 21, 1450.</p> <p>[7] <i>L.A. Wahab.</i> Proceeding of the Second International Conference (Science & Development & Enviroment) Cairo, 1997, 215.</p> <p>[8] <i>A.F.Maged, L.A.Wahab, I.A.El Kholy.</i> J. Materials Science. 1998, 33, 3331.</p> | <p>[9] <i>D.M. Chijikov, V.P. Schastliviy.</i> Selen i selenidi. “Nauka”, M. 1964. (In Russian).</p> <p>[10] <i>H.Mott, E. Devis.</i> Elektronniye processi v nekrystallicheskih veshhestvakh.” Mir”, M. 1982. (In Russian).</p> <p>[11] <i>N.Z. Dzhililov, S.I. Mekhtiyeva, G.M. Damirov i dr.</i> Izv.NAN Azerb., ser. fiz.-mat. i tekhn., fiz. i astr. 2007, (v pechati). (In Russian).</p> <p>[12] <i>S.D. Baranovskiy, E.A. Lebedev.</i> FTP, 1985, t.19, v.6, 1035. (In Russian).</p> <p>[13] <i>N.Z. Dzhililov, G.M. Damirov.</i> IX Mejdunarodnaya konferenciya “Opto-nanoelektronika, nanotekhnologii i mikrosistemi”, Ulyanovsk, 2007. (In Russian).</p> <p>[14] <i>M. Lampert, P. Mark.</i> Injekcionniye toki v tverdkh telakh. “Mir”, M., 1973. (In Russian).</p> |
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**Se-S SİSTEMİNİN AMORF BƏRK MƏHLULLARININ
VOLT-AMPER XARAKTERİSTİKASI**

Qaynar divar üsulu ilə alınmış Se-S sisteminin bərk məhlullarının volt-amper xarakteristikası tədqiq edilmişdir. Cərəyanın qiyməti V_x keçid gərginliyini (omik oblastdan kvadratik oblasta keçid) keçdikdən sonra bütün nümunələrdə artır, yəni tədqiq olunan nümunələrdə injeksiya cərəyanı baş verir. Tərkibindəki kükürdün artması ilə Se-S sisteminin nümunələrindəki lokal halların konsentrasiyasının artması tədqiq olunan nümunələrin struktur müxtəlifliyi ilə izah olunur.

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**ВОЛЬТ-АМПЕРНЫЕ ХАРАКТЕРИСТИКИ АМОΡФНЫХ ТВЕРДЫХ
РАСТВОРОВ СИСТЕМЫ Se-S**

Исследовались вольт-амперные характеристики (ВАХ) пленочных аморфных твердых растворов системы Se-S, полученные методом горячей стенки. При переходе напряжения значения V_x -переход из омической в квадратичную область-ток для всех исследованных образцов увеличивается, т.е. в исследованных образцах возникает инжекционный ток. Увеличение концентрации локальных состояний в образцах системы Se-S с увеличением содержания серы объясняется структурными различиями исследованных образцов.

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