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ELECTROFHYSICAL PROPERTIES OF SILICON CONTACT PREPARED WITH AMORPHOUS METALLIC PbSb ALLOY

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The electrophysical properties of silicon, contact prepared with α(PbSb) amorphous metallic alloy have been investigated in the present paper. The change of diode parameters due to the thermal annealing effect has been studied» It has been found that the properties of the Schottky diodes are sensitive to the structural changes of the metallic film. In. the case of Si contact with the amorphous film of metallic alloys the dimensional dependence of the SD barrier height is weaker as compared to that of the metallic film with a polycrystalline structure.

Recently, great interest is shown in the Schottky diodes (SD) based on the amorphous metal films [1-6]. The amorphous metals in a thin-film state can widely be applied in microelectronics when preparing the active and passive elements. Due to the lack of the boundaries of grains and grain structure, the above materials are firstly attractive in terms of diffusion barriers [3] in construction of integrated circuits on the film structures with a multilevel metallization. Secondly, such films allow to prepare the reliable, qualitative and thermostable elements of integrated circuits [4].

However, with the change of the temperature in amorphous metallic films the structural changes which considerably affect the diode parameters are observed [5]. In this connection, the investigation of electrophysical properties of the silicon contact prepared on the base of the amorphous metallic alloy is of great interest.

The results of studying the electrophysical properties of (PbSb)-nSi Schottky diode are shown in the present paper. In [6] the Pb_x Sb_{100}-nSi Schottky diodes where x=2, 15, 52, 70, 87, 98 have been obtained and the dependences of the main SD parameters on the percentage of components in the alloy at $V>3kT/1$ and $V<kT/1$ have been investigated.

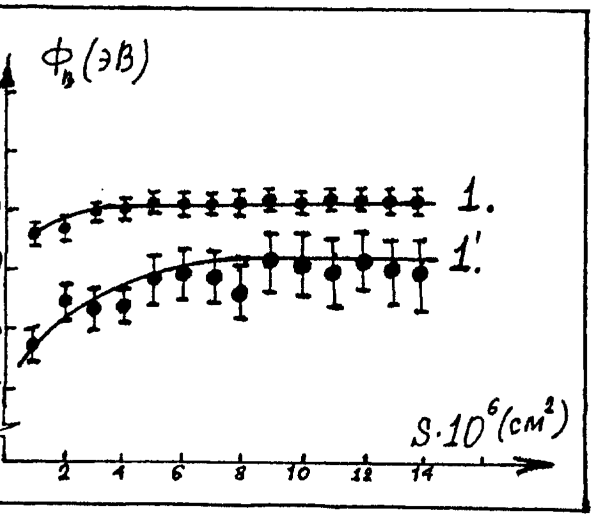


Fig. 1. Dimensional dependences of the barrier height before (1) and after (1') crystallisation of the α(PbSb) amorphous alloy.

The alloy film structure was controlled by electron-microscopic analysis in a transmission electron microscope. The n-type silicon substrate with the /111/ orientation and the resistivity of 0.7 Ohm·cm was used. The diode matrix consists of 14 diodes with the SD areas from 100 to 1400 m^2. The thermal annealing was carried out at temperatures from 323 to 523 K. The annealing time at all temperatures was 10 min. After annealing at temperatures of about 453 K the main SD parameters change abruptly. In our opinion, such a change of the SD parameters is attributed to the change of the metal film microstructure due to the thermal annealing [5].

The dimensional dependences of the barrier height of the α(PbSb) - nSi Schottky diodes before and after crystallization of the α(PbSb) alloy are shown in Fig.l. The barrier heights of α(PbSb) - nSi Schottky diodes were determined from the current-voltage characteristic described by the known formula

$$I = SA_0T^2 \exp\left(-\frac{\Phi_B}{kT}\right)\exp\left(\frac{eV}{nkT}-1\right),$$

where S is the contact area, A_0 is the Richardson constant, Φ_B is the height of the barrier, V is the applied voltage, n is the coefficient of nonideality. As seen in Fig.1, the contact based on the α(PbSb) amorphous alloy has a weaker dimensional dependence of the barrier height, and at the transition of the α(PbSb) alloy to the polycrystalline structure a rather wide range of the change of the barrier height is observed. The spread in the Φ_B value is due to the change of the metal structure.

The electron diffraction pattern of the (PbSb) alloy amorphous films after the thermal annealing is shown in Fig.2. As seen in Fig.2, at 453 K the metal film transforms from the amorphous state to a polycrystalline one. The electron microscopic investigations of the film surface point to this fact (Fig.3).

Thus, one can affirm that the change of the α(PbSb)-nSi SD parameters due to the thermal annealing at temperature of 453 K is attributed to the change of the metallic alloy film structure. The electrophysical properties of the Schottky diodes are very sensitive to the structural changes of the metallic film. In the case of the amorphous metallic film the dimensional dependence of the SD parameters is weaker as compared to that of the metallic film with a polycrystalline structure.

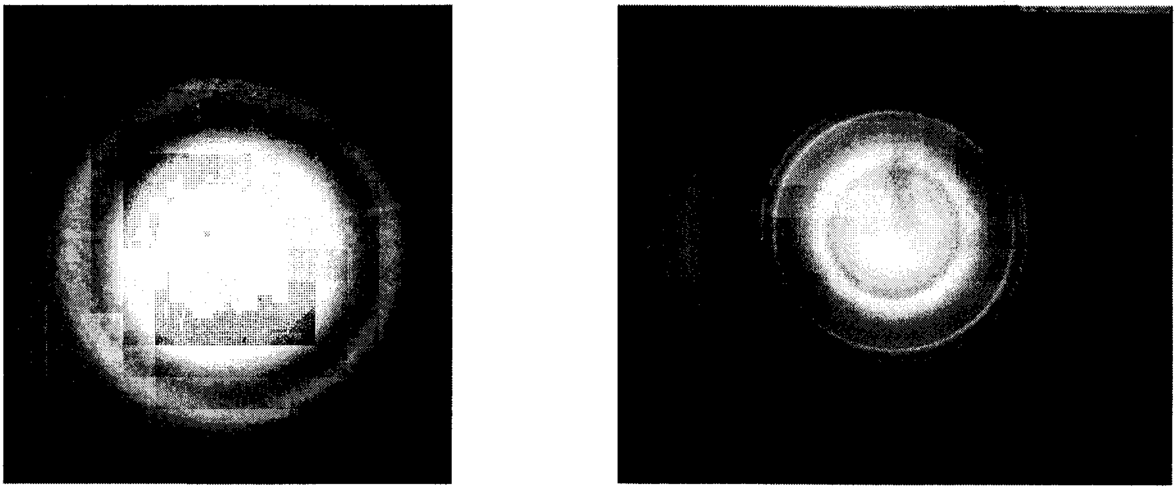
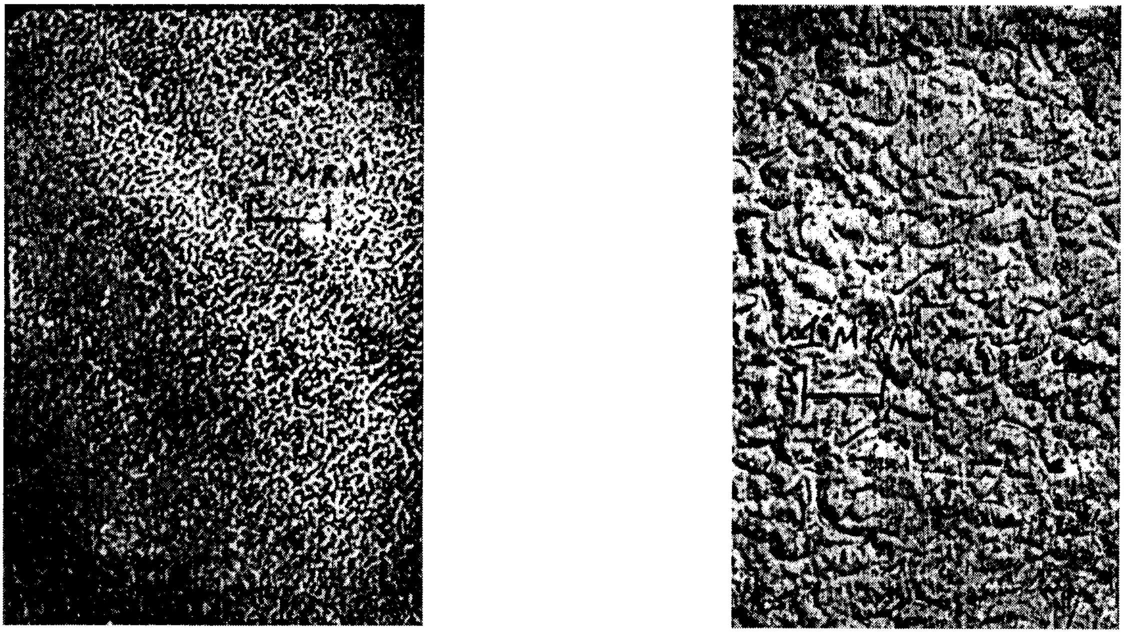

(1) (1')

Fig.2. The electron-diffraction pattern of the α(PbSb) films before (1) and after (1') crystallisations.



(a) (b)

Fig.3. The electron-microscopic investigations of the α(PbSb) film surface before (a) and after (b) crystallisation.

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PbSb AMORF XƏLİTƏSİ ƏSASINDA HAZIRLANMIŞ SİLİSİUM KONTAKTININ ELEKTROFİZİKİ XASSƏSİ

Bu məqalədə α(PbSb) amorf metal xəlitəsi əsasında hazırlanmış silisium kontaktının elektrofiziki xassəsi öyrənilmişdir. Termotablamanın tə'sirindən diod parametrlərinin dəyişməsi tədqiq edilmişdir. Alınmışdır ki, Şotki diodunun xassəsi metal təbəqənin struktur dəyişməsində həssasdır. Silisium əsasında hazırlanmış Şotki diodunun potensial çəpərinin hündürlüyünün ölçü asılılığı təbəqənin amorf struktur olduğu halda polikristal strukturla müqayisədə çox zəifdir.

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ЭЛЕКТРОФИЗИЧЕСКИЕ СВОЙСТВА КОНТАКТА КРЕМНИЯ, ИЗГОТОВЛЕННОГО НА ОСНОВЕ АМОРФНОГО МЕТАЛЛИЧЕСКОГО СПЛАВА PbSb.

В статье изучены электрофизические свойства контакта кремния, изготовленного на основе α(PbSb) аморфного металлического сплава. Исследованы изменения параметров в результате воздействия термоотжига и показано, что свойства ДШ чувствительны к структурным изменениям пленки металла. В случае контакта Si с аморфной пленкой металлических сплавов имеет место более слабая размерная зависимость высоты барьера ДШ, по сравнению с пленкой метала с поликристаллической структурой.

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