RESEARCH OF THE EQUIVALENT CIRCUIT PARAMETERS OF THE (AL-TiW+PtSi)-nSi SHOTTKY DIODES

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ABSTRACT

C-V and G/ω characteristics of (Al-TiW+PtSi)-nSi) diodes have been obtained in a wide temperature range. The analysis of the determined data has revealed presence of the fixed charge on interface and the deep center in the band gap. Influence of surface states results in display of inductive properties of the diode.

Keywords: Schottky diodes, barrier, tunnelling, inhomogeneties, conductivity.

I. INTRODUCTION

Devices on the base of the metal-semiconductor contacts plays a great role in modern development of the technics. With the purpose of satisfaction of requirements of semi-conductor instrument making the big attention is given studying of electric, physical parameters and mechanisms of carry of charges of contact structures. The small area of the metal-semiconductor contact provides a small capacity and in result a high speed of contact [1].
Characteristics of diodes on the basis of the metal - semiconductor contact are rather sensitive to a condition of interface. Even the insignificant quantity of surface states and levels in the field of a spatial charge can render essential influences on instrument characteristics. In result the scope of this device radically changes.

II. EXPERIMENT AND DISCUSSION OF RESULTS

In the present paper (Al-TiW+PtSi)-nSi diodes on the basis of Shottky barrier, obtained by a magnetron sputtering method hawe been investigated. A film were besieged on silicon plate n-type (mark KEF-0,7) with orientation (111). Formation of the silicide results in displacement of the metal - semiconductor interface deep into the semiconductor. As diffusion barrier between a films PtSi and Al the amorphous alloy of two inert metals Ti and W ($Ti_{10}W_{90}$) is located. The diodes matrix contains 14 diodes with the areas (1-14) $x10^{-6}cm^{-2}$. In the present paper the results of research of diodes №8 and №11 have been analyzed.

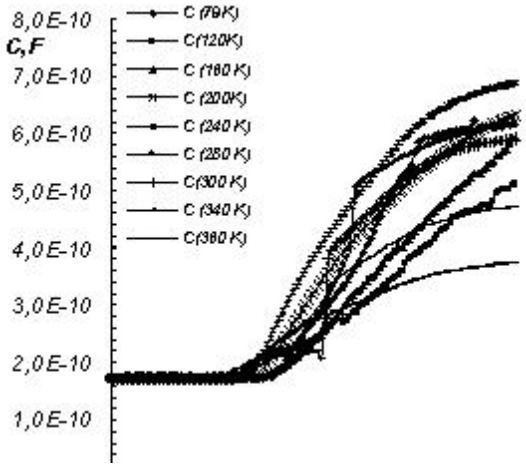

Fig 1. C-V in a temperatures interval (79-360)K - (the diode 8)

Measurements of C-V of characteristics and parallel conductivity G have been carried out with use of impedance analyzer HP4192A LF in a wide range of values of a constant voltage and a variable voltage (10mV) at frequency ω=100 kHz/2/. As small sinusoidal signal 10 mV p-p from the external pulse generator is applied to the sample in order to meet the requirement [2].

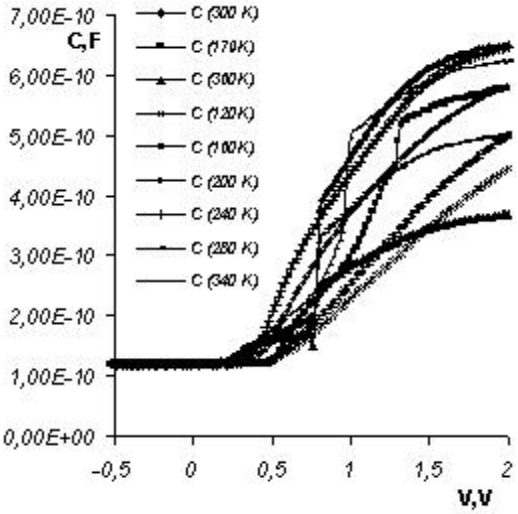

Fig. 2. C-V in a temperatures interval (79-360)K – (the diode 11)

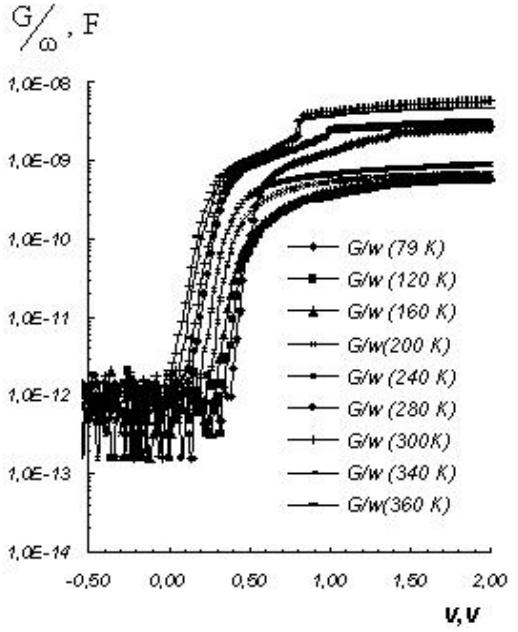

Fig. 3 G/ω in a temperatures interval (79-360) K (the diode 8).

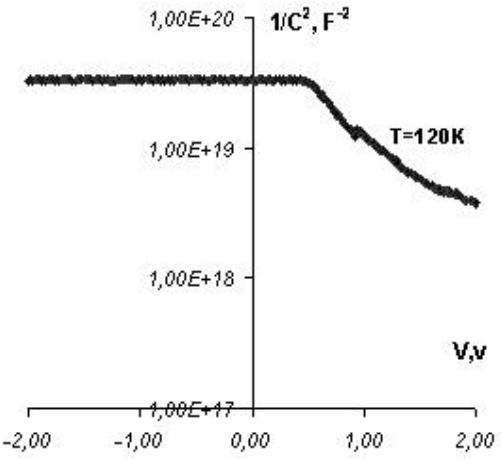

Fig.4 Dependence $1/C^2$ from displacement V (120K).

The analysis of obtained C-V shows, that in some approximation dependence $1/C^2$- deviates is a straight line. Analysis C-V of the diode №8 (Fig. 4) has revealed break of function at temperature 120K, at a voltage of displacement 0,94V, that is connected to existence of the deep center in the field of a spatial charge, which power position is Ei-Ev=0,26 eV.

On C-V characteristics of the diode №11 at 120K, 160K a break of functions has not been revealed , practically. However, nonlinear character C^{-2} (V) specifies that the concentration chance of carriers within the limits of area of a spatial charge is nonlinear - full concentration is defined by the sum of initial concentration N_d and concentration of charges on deep center N_{DC}. The increase of diodes areas did not influence value of capacity, practically. Step change of capacity which seems to constants, speaks about existence of a network of levels with small concentration of charges in area of a spatial charge (ASC).

On the basis of dependence $C^{-2}(V)$ [3] ,

$$C^{-2} = \frac{8\pi}{\varepsilon_2 q^2 (N_d + N_{DC})}\left[\varphi_0 - \frac{(E_i - \mu_0)N_{DC}}{N_d + N_{DC}} - qV_2\right]$$

(where V_2-the voltage failure in ASC, other designations are standard) the expression for calculation of concentration of charge N_{DC} on the deep center have been obtained

$$N_{DC} = \frac{(C_2^{-2} - C_1^{-2})N_d}{C_1^{-2}}$$

where C_1 and C_2 are the dates of capacity in a point of function break. As a result of calculations at 120K $N_{DC} = 6{,}42 \times 10^{14} cm^{-3}$ have been obtained.

Even at small positive voltage the capacity practically does not depend on a voltage. Displacement C-V aside positive voltage (dV = (0,5 - 0,3) V in the field of temperatures (79-360) K) shows, that there is a fixed negative charge which is located near to border of the unit. As is known its size depends on orientation of a substrate, technological modes and annealing of the structures /1/. With increase in temperature the shift of C-V decreases. Hence there is a neutralization of the fixed negative charge.

G/ω exponential depends on a voltage and does not grow at a return voltage, that well correlates with the theory for metal-semiconductor contact.

III.CONCLUSION

As a result of the analysis of dependence negative values G/ω have been revealed at negative displacement and positive displacement up to 0,3V. It is known, that negative value G/ω is connected to surface states conditions and specifies inductive character of the structure.

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