ANALOGUE OF THE INDUCTANCE ON THE BASIS OF (Al-TiW+PtSi)-nSi SHOTTKY DIODE

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Большой интерес для электроники представляют аналоги индуктивности на основе полупроводниковых приборов. Были исследованы сэндвич структуры (Al-TiW+PtSi)/nSi, полученные методом магнетронного распыления. Диодная матрица содержит 14 диодов, площади которых изменяются от $1x10^{-6}$см^2 до$14x10^{-6}$см^2. На основе анализа вольт-фарадных характеристик и зависимостей параллельной проводимости диодов Шоттки на основе **(**Al-TiW+PtSi)/nSi от напряжения было выявлено, что при определенных значениях напряжения и температуры диоды играют роль индуктивности.

Analogues of the inductance on the basis of semiconductor devices represent the big interest for the electronics. The sandwich structure (Al-TiW+PtSi)/nSi by magnetron sputterin method has been obtained. The diode matrix contained 14 diodes the areas of which changed from $1x10^{-6}$cm^2 to $14x10^{-6}$cm^2. On the basis of the analysis of volt-capacity characteristics and parallel conductivity of **(**Al-TiW+PtSi)/nSi Shottky diodes has been revealed, that at the certain values of a voltage and temperatures the diode plays a role of the inductance.

1. INTRODUCTION

The method of the localization of a magnetic field in the semiconductor is one of unresolved problems of the microelectronics. In this connection indirect methods of the creation of the analogues of inductive elements have got a special value [1]. It is known, that the inductive effect of semiconductor devices is caused by inertial properties of charges. Diodes on a basis p-n transition, inductive transistors and dinistors have inductive properties. Devices on the basis of the metal-semiconductor contact under certain conditions can play a role of the inductance [2]. The basic electrophysical parameters of semiconductor devices on a basis of Shottky barrier depend on a choice of contacting materials and of technological process of the contact's obtaining [3,4,5].

2. EXPERIMENTAL DETAILS

On the basis of the analysis of volt-capacity characteristics and parallel conductivity of (Al-TiW+PtSi)/nSi Shottky diodes has been revealed, that at the certain values of a voltage and temperatures the diode plays a role of the inductance. The (Al-TiW+PtSi)/nSi Shottky diodes were fabricated by a magnetron sputtering method on n-type single crystal silicon wafer(ρ =0,7Ohm×cm, orientation n-Si is (111)). In present paper results of research of diodes with the size $8x10^{-6}$cm^2 are submitted**.** The volt-capacity (C-V) and parallel conductivity G_p measurements were performed by the use of a HP 4192A LF impedance analyser (5Hz÷13MHz) under a small sinusoidal signal 10mV p-p from the external pulse generator is applied to the simple in order to meet the requirement. Measurement current out in a wide range of the voltage $(-2 \div 2)$V, temperatures (79÷360)K and frequency (10÷ 100) kHz.. The carried out researches have shown, that parallel conductivity achieves the maximal value at the frequency 100kHz.

3. RESULTS AND DISCUSSION

The characteristic G_p / ω(V) obtained in a wide temperature range (79÷360K) is displaced to the area of positive voltage. It specifies existence of the negative fixed charge on metal-semiconductor interface, which decreases with the increasing of the temperature [6]. The dependences are linear at the voltage (0,78 ÷1,44)V for the different temperature. The reverse bias G_p / ω(V) does not increase. It specifies that metal-semiconductor contact is intimate or existence of very narrow gap between metal and semiconductor. At the certain values of a voltage and temperatures G_p / ω has negative values [7].

The important feature of the contact with surface states is the dependence of the conductivity and capacities on the frequency. In this case general conductivity of the contact G is

$$G = G_b + G_s \qquad (1)$$

where, G_b and G_s - the conductivity, describing currents without the participation of surface states and currents through surface states, accordingly. Then general capacity is:

$$C = C_b + C_s + C_2\alpha_0 , \quad \alpha_o = \left(1 + \frac{\varepsilon_2 d}{\varepsilon_1 L} \right)^{-1} \qquad (2)$$

where C_b is the capacity connected to the shift of phases due to recharging of surface states, which do not take part in current transfer; C_s -the capacity describing of current transfer

through surface states; C_2 is capacity connected to Macswell's currents of displacement, L- the width of depletion layer, d- the width of dielectric gap, ε_1 is the permittivity of interfacial dielectric layer and ε_2 is the permittivity of depletion layer**,** accordingly [7].

At performance of a condition $|C_b| > (C_s + C_2)$ jet part of contact's resistance shows inductive character. In this case surface states redistribute a charge changing a voltage in a dielectric gap and in the region of a depletion layer and do not take part in current transfer. Negative value C_b corresponds to a change of a phase due to the redistribution of charges. It corresponds to display of inductive properties of diodes.

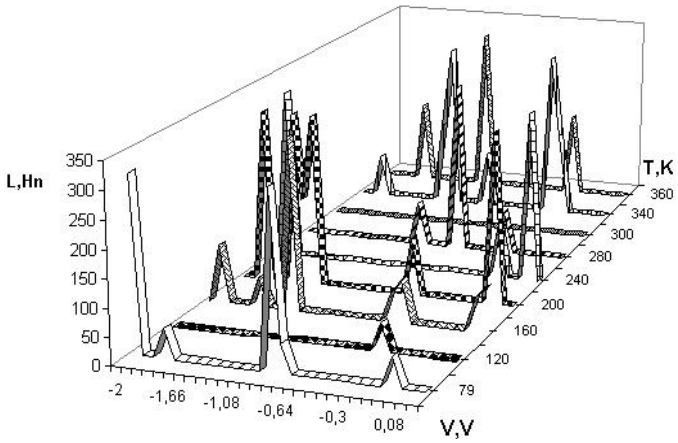

Fig.1 Dependence of the inductance of (Al-TiW+PtSi)-nSi Shottky diodes on a voltage and temperatures.

In this case inductance of the diode is equal [2]

$$L = -\frac{1}{2\omega G_p}, \quad \text{where } G_p = C_b\omega/2$$

when

$$\omega\tau = 1 \tag{3}$$

(ω - frequency of signal; τ - the time of surface states recharge).

The method of the conductivity provides higher accuracy of the definition of surface states density. It is especially important at the research of structures with rather small surface states density (about $10^{10}sm^{-2}eV^{-1}$) [7]. Thus, it is possible to investigate inductive properties of the diode measuring parallel conductivity. On the base above described theory has been revealed inductive properties of (Al-TiW+PtSi)/nSi Shottky diodes. İn the result of investigation we have: inductance of (Al-TiW+PtSi)/nSi diode changes in an interval (105÷315)Hn. Its dependence on a voltage corresponds to delta – function, practically (Fig.1).

5. CONCLUSION

(Al-TiW+PtSi)/ nSi Shottky diodes can play a role of analogues of inductance. By the creating the certain surface states it is possible to use the diode as inductance.

With rise in temperature in the field of positive displacement inductive properties of the diode weaken, that is connected to neutralization of the fixed charge on a semiconductor - dielectric gap's interface, apparently.

Negative value of C_b in the field of direct voltage is caused by primary electron's exchange of surface states with the metal, at return displacement it corresponds to a primary exchange surface states- semiconductor [7].

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