

Learning The Effect Of External Compression On Lead Silicate Ceramic Compound

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Annotation. The effect of ultrasonic action on the density of electronic states localized at the Si-glass interface is studied. A method is proposed for determining the surface and volume generation rates of charge carriers using the calculated time dependence of the space charge region width (SCR) when comparing it with the experimental dependence. Ultrasonic treatment of Al-n-Si - glass - Al structures with a frequency of 2.5 MHz and a power of 0.5 W for 40 minutes leads to a decrease in the rate of charge formation of the inversion layer. This is due to a decrease in the integral density of electronic states localized at the semiconductor-glass interface and does not affect the energy spectrum of bulk electronic states in a semiconductor.

Keywords. Ultrasonic irradiation, C-V characteristics, localized states, relaxation, carrier generation, dielectric losses, interphase boundaries, isothermal relaxation of capacitance.

Introduction

Component practically all modern semiconductor devices is the combination of alternating layers the semiconductor - dielectric.

In such devices as field transistors, surface barrier variable capacities, memory elements, devices with charging communication contact the semiconductor - dielectric is the main working area. In the majority other semiconductor devices contact the semiconductor - dielectric carries out support functions: dividing isolation, passivation and protection of a surface of the semiconductor against external influences. In all cases the physical processes occurring on limits of the section the semiconductor - dielectric make essential impact on performance data of semiconductor devices.

The semiconductor dielectric a large number of works is devoted to studying of influence of external impacts on properties of transitional layers. But these works are, as a rule, devoted to research of most widely used system silicon - silicon dioxide [1-4].

However, in some cases, the system silicon - dioxide of silicon possesses some shortcomings. To such shortcomings high temperature (900-1200 °C) formations of a layer SiO₂ leading to redistribution of the impurity centers for thickness to a semiconductor substrate, caused by various factors of a segregation [4] and belongs to emergence in the semiconductor of the thermo defective centers.

Lead -borosilicate glasses flew down are free from these shortcomings. Moreover, use fusible lead borosilicate glasses allows to combine high insulating characteristics and simplicity of receiving dielectric coverings. From this point of view studying of the nature of the electro physical processes proceeding in coverings on a basis lead - borosilicate glasses is actual at external influences.

For research type glass PbO - SiO₂ - B₂O₃ - Al₂O₃ - Ta₂O₅ with mass percentage of components 49:32:15:3:1 was used, put on a surface of plates of n-silicon (10 Ω cm, with crystallographic orientation <111>) from small dispersion solution, with the subsequent melting (T = 680 °C) and heating (T = 470 °C). For measurements of electric characteristics type structures Al - lead - borosilicate glass - n-Si made by means of a method, described in [5] were used. The thickness of a layer of glass made 2000-2500 angstry. Aluminum was put by means of vacuum sedimentation. Diameter of operating electrodes of 3 mm. By means of a method high-frequency (1 MHz) the volt-farad (C-V) characteristics [6] in all made structures was observed well expressed hysteresis. However in the structures subjected to all-round compression to pressure in 5 Kbar on installation «Hydrostat-16», the hysteresis of characteristics was not observed, even at measurements in intervals of temperatures -20 ÷ +80 °C.

According to the existing theories, parallel shift of volts-farad of characteristics of structures of MGS (made on the basis of the semiconductor of electronic type such as conductivity) towards negative tension indicates formation of a positive charge in glass structure. And change of a form of volts-farad characteristics of such structures, testifies to increase in a charge of superficial conditions which are recharged at change of size of enclosed tension. Existence of a mobile charge in structure lead - borosilicate glasses can be caused by the localization, injected of the semiconductor, electrons near easily polarizable ions of lead and their accumulation on potential barriers of inclusions of a crystal phase [3]. For confirmation of the assumption on formation of the mobile positive charge in glass of studied structures, before pressure influence, the tangent of angle of dielectric losses was measured at various temperatures (-10 ... +50 °C) and frequencies (100 kHz...2 MHz). Comparison of the received temperature and frequency dependences a tangent of angle of dielectric losses allowed to establish that in all measured structures the tangent of angle of dielectric losses has a characteristic relaxation maximum. And in the structures subjected to pressure of bigger 3 Kbar, dielectric losses considerably increase.

As change of extent of polarization of ions of lead by means of external mechanical influences is represented improbable, change of height of potential barriers between inclusions of a crystal phase can be the main reason leading to reduction of the hysteresis phenomena. Really, influence of pressure lowers of height of potential barriers leads to reduction of depth of a potential deepening. Thus, injected, enclosed by enrichment bias voltage, from the semiconductor electrons, are not localized in

large numbers in potential holes, come back, at change of polarity of voltage, back in the semiconductor. In favor of this reason temperature dependences of a tangent of angle of dielectric losses testify. In structures subjected to influence by pressure the relaxation maximum of dielectric losses decreases and becomes less strongly pronounced.

For confirmation of the offered model, we made structures with the reduced content of lead in glass. Mass percentage of components of glass $\text{PbO} - \text{SiO}_2 - \text{B}_2\text{O}_3 - \text{Al}_2\text{O}_3 - \text{Ta}_2\text{O}_5$ in these structures made 42:39:15:3:1 Control measurements of volts - farad characteristics, in similar conditions, essential reduction of a loop of a hysteresis showed.

Recently we showed [7] that in the structures made on the basis of SiO_2 , influence of pressure leads to reconstruction by a semiconductor layer, about limit of the section the semiconductor - dielectric and these structures change some dynamics characteristics. However in structures made on the basis of silicon n - such as the conductivity, covered with a layer lead borosilicate glass, speed of surface generation is the same function of time, as well as for structures subjected to pressure. Therefore, in these structures reconstruction of surface at pressure influence to 5 Kbar does not occur.

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