R4-O-026101

INFLUENCE OF ELECTRON IRRADIATION ON THE ELECTROPHYSICAL PARAMETERS OF SILICON DOPED WITH COBALT

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The paper presents the results of studies of doped single-crystal silicon irradiated with electrons with an energy of 4 meV in the fluence range of $10^{14} \div 10^{16}$ cm^{-2} depending on the concentration of introduced cobalt and the effect of induced radiation defects on the electrical parameters Si<Co>.

Silicon wafers of KEF grade of n-type conductivity with resistivity from 2 to 6 Ohm cm, dislocation density of ~10^{14} cm^{-2}, and oxygen content of $5 \cdot 10^{17}$ cm^{-3} were used as the starting material. Diffusion of Co was carried out from a metal layer deposited in vacuum to the cleaned surface of the Si plates at temperatures of 1050÷1250 ^{0}C for 8÷10 hours. Comparison of electrophysical parameters of control and doped silicon samples after diffusion at 1250 ^{0}C showed that the values of resistivity (ρ) increase by 2÷3 times, and the concentration of free charge carriers also decreases within the specified limits. Such a change in the electrical parameters allows us to state that the admixture of in cobalt n-Si mainly exhibits acceptor properties and not amphoteric [1] and leads to compensation of the main current carriers.

The solubility of Co in Si was determined by neutron activation analysis, and the positions of deep centers in Si<Co> were determined from the Hall coefficient. At the same time, it was found that the total concentration of cobalt in the indicated temperature range varies within $9 \cdot 10^{14}$ cm^{-3} to $1 \cdot 10^{16}$ cm^{-3}, and the electrically active concentration is $4 \cdot 10^{13}$ cm^{-3} to $3 \cdot 10^{14}$ cm^{-3}, due to the capture of electrons deep centers located in the upper half of the band gap with ionization energies E_c-0.41 eV and E_c-0.53 eV.

To study the radiation degradation of the Si<Co> parameters, reference and doped samples were irradiated at an electron accelerator "Electronics U-003" at a flux density of $5 \bullet 10^{11}$ cm^{-2}. The temperature of the samples during irradiation did not exceed 40 ^{0}C.

It has been established that irradiation with electrons with an energy of 4 meV in the specified fluence range leads to a change in the values of ρ and the rate of removal of the current carrier concentration (n_e) both in the doped and in the control samples. In Si<Co> samples, the degradation efficiency is determined by the concentration of the electrically active cobalt center. Its increase in samples leads to an increase in the efficiency of degradation of electrophysical parameters compared to the reference control samples. Comparison of the degradation coefficients ρ and ne ($K_{\rho(ne)}$) at the same doses of electron irradiation 10^{16} cm^{-2} has shown that an increase in the concentration of electrically active Co centers from 4×10^{13} cm^{-3} to 3×10^{14} cm^{-3} leads to an increase in the value of $K_{\rho(ne)}$ by 1.3 times, and in comparison with undoped samples by 3 times, i.e. doping silicon with cobalt leads to a decrease in the radiation resistance of the electrophysical parameters of silicon, and not to an increase, as shown in [2]. The mechanism has been proposed for the occurrence of quasi-chemical reactions due to radiative decay of electrically inactive complex states of cobalt in a Si-Co solid solution with the subsequent formation of acceptor centers in the silicon interstices [1], which is indicated by an increase in the concentration of deep centers of cobalt after irradiation with electrons and an increase in their concentration with dose irradiation.

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