THE ROLE OF DISLOCATIONS IN RADIATION-STIMULATED CHANGES IN THE ELECTROPHYSICAL AND OPTICAL CHARACTERISTICS OF SILICON STRUCTURES

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Introduction

The development of modern nanoelectronics in terms of significant reduction of elements makes increased demands on the state of the near-surface layer of silicon structures. After all, unstable processes that occur at the boundaries of the separation under the influence of external factors determine the operational parameters of these elements. The presence of point and linear defects can significantly affect the activity of the surface. This can affect the efficiency and durability of solar cells under the action of weak electromagnetic fields.

Methods

Silicon mono-crystals of *p*-type conductivity, grown by Czochralski method (ρ = 10 *Ohm·cm*) were used in the research paper.

Experimental samples obtained dimensions 3.55 x 3.99 x 7.60 *mm* after sanding and chemical polishing. Ohmic contacts in the form of two strips with width 2.0 *mm* at the ends of the sample surfaces (111) were created by thermal evaporation of aluminum in a vacuum (10^{-3} *Pa*) at heated to 593 *K* sample.

A *p*-Si sample was placed in a darkened working chamber between the clamps of the press.

The samples were irradiated with a full range of X-radiation (*W*-anode, 50 *kV*, 10 *mA*), on both sides, on which aluminum contacts were coated. The distance between the source of X-rays and crystals was minimal (1-2 *mm*). it was found that the absorbed dose was increasing by 130 *Gy* in every 30 minutes. In the work, we firstly irradiated the experimental samples and afterwards we measured the resistance in the process of deformation.

Results and Discussion

The aim was to form a surface-barrier and light-emitting structures (LES) based on *p*-Si crystals with different concentrations of dislocations on the surface of the semiconductor substrate and to investigate the change in their electrophysical and optical characteristics under the influence of X-rays. Changes in the surface resistance of silicon single crystals, volt-farad characteristics, the density of surface states, and electroluminescence of LES were analysed.

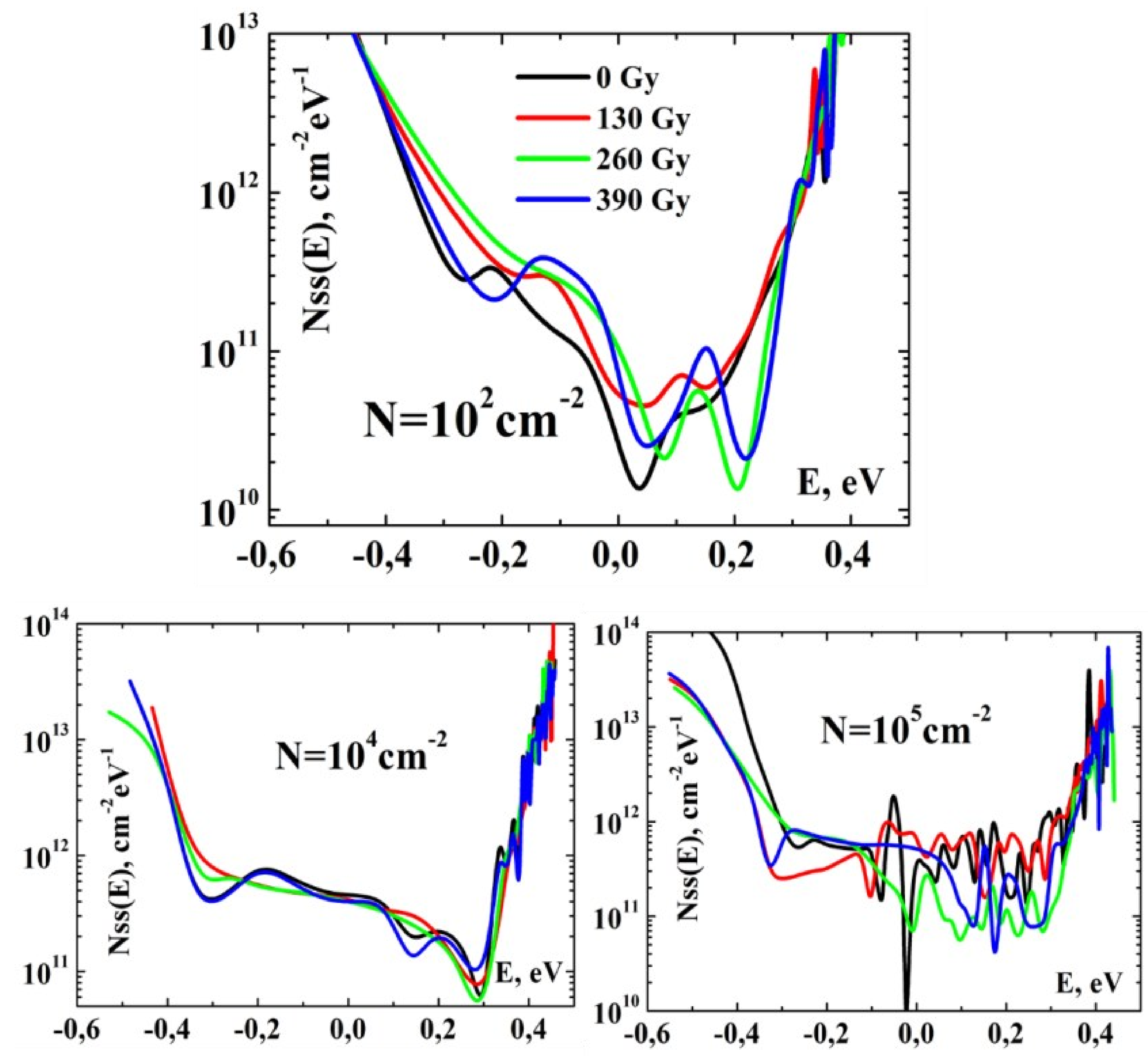

Fig. 1 – Radiation-stimulated changes in the Si-SiO_2 charge of the Bi-Si-Al diode structure with different concentration of dislocations on the surface of the Si (111) substrate (distribution of the density of surface states in the band gap)

As the concentration of dislocations increases, the surface resistance of silicon increases. The reason is the process of generating the main charge carriers by linear defects. As the X-ray dose increases, the *p*-Si resistance increases further. The resistance of unirradiated and irradiated samples of solar silicon under elastic compression decreases. With increasing dislocation concentrations greater than 10^4 cm^2, there is a certain nonmonotonicity of charge accumulation at the Si-SiO_2 interface, which is associated with the additional influence of the mechanical field of dislocations and the electric field of the Cottrell cloud on X-stimulated changes in these structures.

Conclusions

It is shown that high concentrations of dislocations on the surface (111) of silicon are generated by the methods of plastic deformation and high-temperature annealing in an oxygen atmosphere. This allows creation of highly efficient radiating Al-Si(*p*) structures.