FEATURES OF MECHANICALLY STIMULATED CHANGES OF ELECTRICAL CONDUCTIVITY OF X-IRRADIATED p-Si CRYSTALS

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Introduction

The development of modern microelectronics and sensor technology is inextricably linked with the creation of functional materials based on silicon crystals with predetermined and stable physical properties.

Mechanical properties of silicon, as well as, other semiconductors are mainly determined by the subsystem state of structural defects. Under the influence of irradiation, radiation defects play a major role in changing the characteristics.

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

Mechanically stimulated changes in the electrical conductivity of irradiated and non-irradiated *p*-Si crystals have been studied. It is established that a section of weak dependence of the change *R(σ)* begins to form with each subsequent compression-expansion cycle in the graph of resistance to mechanical load (*R(σ)*) on the initial section of the deformation action (Fig. 1).

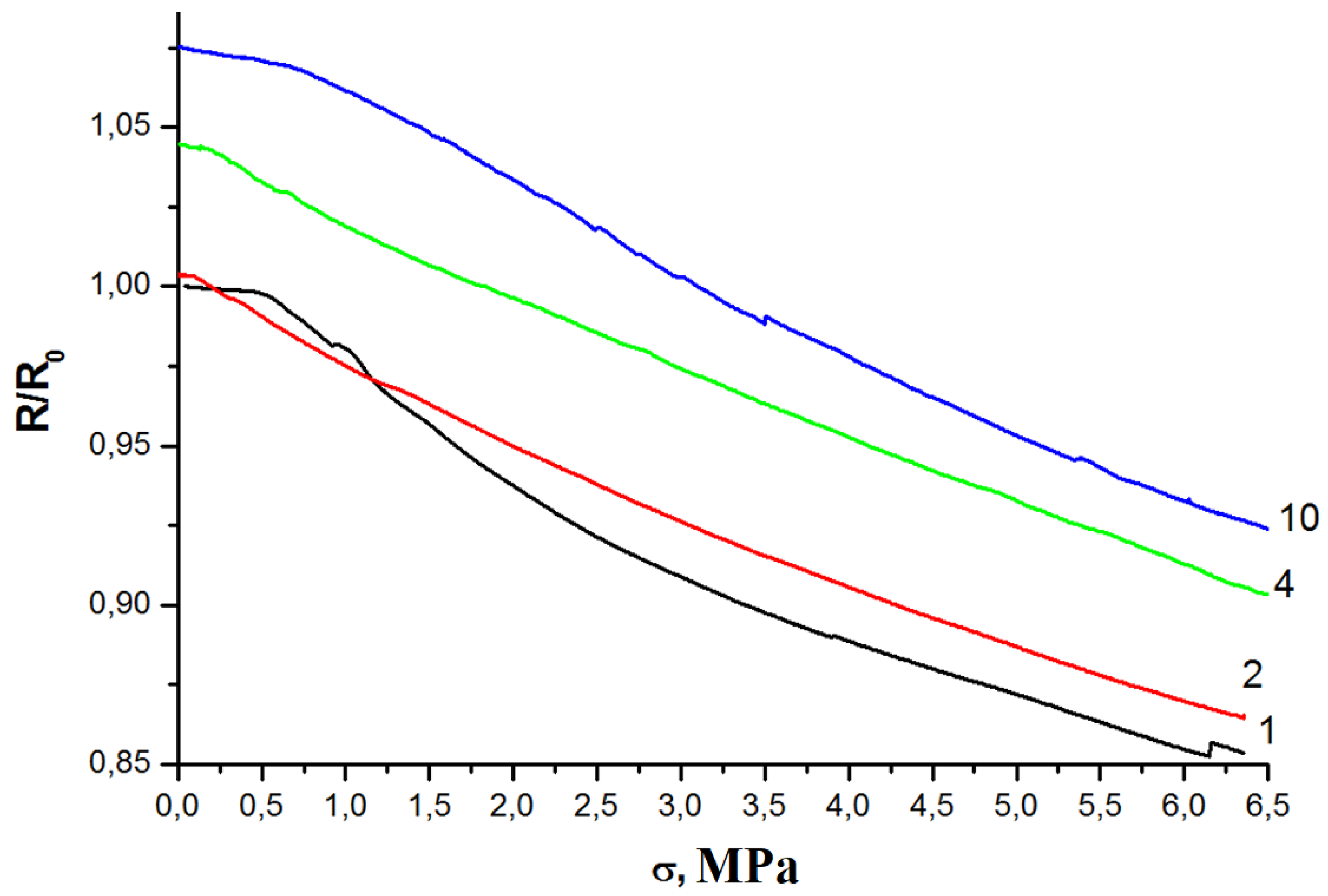

Fig. 1 – **Mechanically stimulated change of electrical conductivity of elastically deformed crystals: 1 – first deformation; 2 – second deformation; 4 – fourth deformation; 10 – tenth cycle of elastic deformation.**

The mechanically stimulated increase in the value of the electrical resistance of the irradiated *p*-Si crystals is due to the generation of electrons, which in the process of deformation are captured by mobile dislocations and carried to the near-surface layer, where they recombine with the main charge carriers. After completion of recombination processes, mechano-stimulated changes in the resistance of the sample are described by the laws of unirradiated crystals.

Conclusions

As the number of cycles of elastic deformation in the crystal increases, both point and more complex lattice defects accumulate, which form clusters of different sizes due to the motion of dislocations. As a result, internal mechanical stresses are generated. These macro-defects are able to localize charges. Under uniaxial compression, mobile dislocations can facilitate the transfer of electrons to the crystal surface. The appearance of characteristic maxima on the dependence graph *R(σ)* can be an indicator of the beginning of irreversible mechanically stimulated changes in the crystal structure.