Radiation-Enhanced Diffusion of Phosphorus in Silicon

O. I. Velichko

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Belarusian State University of Informatics and Radioelectronics, P. Brovka St. 6, Minsk, 220013 Belarus

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Abstract: Modeling of the phosphorus radiation-enhanced diffusion in the course of implantation of high-energy protons into an elevated-temperature silicon substrate and during its treatment in a hydrogen-containing plasma was carried out. It follows from the results obtained that the radiation-enhanced diffusion occurs by means of formation, migration, and dissociation of "impurity atom – silicon self-interstitial" pairs being in a local thermodynamic equilibrium with substitutionally dissolved impurity and nonequilibrium point defects generated due to external irradiation. The decrease of the average migration length with the proton energy can be due to the interaction of silicon self-interstitials with the vacancies generated at the surface or with the defects formed in the phosphorus implanted region. Based on the pair diffusion mechanism, a theoretical investigation of the form of impurity profiles that can be created in thin silicon layers due to the radiation-enhanced diffusion was carried out.

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