

## Vacancy-phosphorus complexes in electron-irradiated floating-zone *n*-type silicon: new points in annealing studies

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Annealing processes of vacancy-impurity atom pairs in moderately doped *n*-type silicon grown by the floating-zone technique and subjected to 0.9 MeV electron irradiation are investigated by means of Hall effect and conductivity measurements taking over a wide temperature range of 20 to 300 K. Changes in the total concentrations of shallow donors and compensating acceptors in samples prior to and after irradiation as well in the course of isochronal annealing in a temperature interval of 100 to 700°C are determined. It is demonstrated that the Fermi level at annealing stages between 100 and 260°C plays an important part in recovery of the electrical properties of irradiated samples. There is evidence that the first annealing stage between 100 and 160°C is associated with limited migration of vacancy-impurity atom pairs and their trapping by free phosphorus impurity atoms. As a consequence, complexes of vacancy-two impurity atoms appear. They are stable up to 600°C. The complete restoration of the electrical parameters of irradiated samples is observed at 700°C.

**Keywords:** silicon, irradiation, vacancy-phosphorus complexes, annealing.

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