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Annealing Properties of N-Doped CZ-SI Crystals

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Annealing properties of N-doped CZ-Si crystals were quite different from that of CZ-Si crystals. Electrical measurements showed that the resistivity increases for the p type N-doped CZ-Si crystals but decreases for the n type CZ-Si crystals when samples were annealed in the temperature regions of 300 - 500°C, it reveals that electrically active donors like the thermal donors (TD) were generated during the annealing. Isothermal annealing at 400°C showed that the donor increases with annealing time and its concentration reaches a maximum value of ~ $3x10^{16}$ cm^{-3} for the samples with $[o_i]$ ~ 10^{18} cm^{-3} and $[N_2]$ = $1.5x10^{15}$ cm^{-3}. Spreading resistance measurements showed that the donors generated is well distributed along diameter. In the annealing temperatures of 500 - 900°C, the resistivities for both n and p type samples maintain constants approximately, the resistivity value was higher than its initial ones for the n type sample but was lower than its initial ones for the p type sample. We also found that the donors generated at 400°C annealing can be eliminated rapidly by a subsequently high temperature (T > 600°C) annealing. These results reveal that no electrically active donor like the new thermal donors (ND) were generated and the donors generated during the crystal growing can be eliminated by a high temperature annealing. Infrared absorption measurements showed that the nitrogen concentration maintains approximately at a constant during the low temperature (T < 500°C) annealing but is eliminated at a high temperature (T > 600°C) annealing. By comparing the results of the resistivity shifts and the changes of nitrogen concentration in samples annealed at different conditions, we may conclude that the existence of nitrogen in CZ-Si crystals enhances the TD formation but suppresses the ND formation.