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Optical studies of defect centers formed in MCz-Si and FZ-Si by high-fluence neutron irradiation

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Photoluminescence (PL) and infrared absorption (IRA) techniques have been applied to study defect centers formed in MCz and FZ by high-fluence neutron irradiation. The MCz-Si and FZ-Si samples prepared by the WODEAN group were irradiated with neutron fluences ranging from 1x10ˆ14 to 3x10ˆ16 cmˆ-2. The studies were performed in a temperature range of 13 K–100 K using both the as-irradiated and subjected to isochronal annealing samples. The annealing temperature ranged from 300 to 780 K and the time was 1 h or 0.5 h. The PL measurements were mainly concentrated on the intensity changes of the W (I3) and I4 lines, commonly assumed to be related to complexes built of tri- and four- silicon interstitial atoms, respectively. Temperature dependence for the W line intensity was measured in a temperature range of 13–110 K. The quenching process energy for the W line was found to be 0.3 eV, what is closed to the activation energy for vacancy diffusion. Assuming that W-line is a tri-interstitial complex (I3), this could suggest that the annihilation of the W-line at 1.018 eV is due to vacancy - interstitial recombination process. From the Arrhenius plot for the I4 line, •the activation energy for increasing the I4 line (1.039 eV) intensity was found to be nearly the same as that for decreasing the W line (1.018 eV) intensity and was equal to (0.75 +/- 0.15) eV only in a very narrow temperature range. This would suggest that the tri-interstitials can be the precursors for the formation of I4 centres in this temperature range. The IRA measurements were focused on the study of the absorption coefficient related to the divacancy (V2) in neutral and negatively charged states. From these measurements, the concentrations of V2(0) and V2(-) for various neutron fluences were determined and the rates of their formation have been found to be 0.3 cmˆ-1 and 0.13 cmˆ-1, respectively.

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