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Optical Absorption Study of Ion Implanted Si Films

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In this work we present an optical absorption study of ion-implantation damage in films of Si on sapphire. The absorption spectra were obtained by photothermal deflection spectroscopy, a highly sensitive technique, which enabled the extension of the spectra from ~ 2.8 eV down to an energy far into the sub gap region of Si (~ 0.35 eV). The various stages of formation and quenching of divacancies were monitored as a function of implantation conditions and annealing cycles through their 0.68 eV (1.8 μm) absorption band. It was found that divacancies increased with dose up to a concentration of ~ 10^{20} cm^{-3} and then progressively became quenched with further dose increase. Moreover, in the band edge region, the inverse logarithmic slope value closely correlated with the divacancy concentration, indicating that divacancies strongly affect the population of band tail states. This was also confirmed in the studies carried out during annealing, where it was found that divacancies anneal out over a narrow temperature range around ~ 230 °C. In ion-implanted amorphous material the evolution of the values of the optical gap and inverse logarithmic slope during annealing revealed that structural relaxation is associated with strain reduction in the material, whereas analysis of the sub gap features indicated that it is also accompanied by a reduction in defect concentration.