Infrared Study of Defects in Nitrogen-Doped Electron Irradiated Silicon

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Abstract:
Silicon is the main semiconductor material for many electronic devices. Nitrogen is a key dopant in Cz-Si widely used to control properties if Si wafers in microelectronics. Most of these properties are affected by these defects and their processes. FTIR spectroscopy is an important experimental technique to investigate the properties and generally behaviour of defects in materials.
In this work we investigate the existence of N-related defects and their annealing characteristics as well as the impact of N-doping on the production and evolution of *V*O defect in irradiated Si, by means of FTIR spectroscopy. We used N-doped Cz-Si samples (with [N] $=5\cdot10^{14}$ cm^3) which were electron irradiated at a fluence of $2x10^{18}cm^{-2}$ and then subjected to 20 min isochronal anneals in 10^oC steps up to 600 ^oC.Fig.1 presents the Infrared spectra of the sample (a) before irradiation, (b) after irradiation.

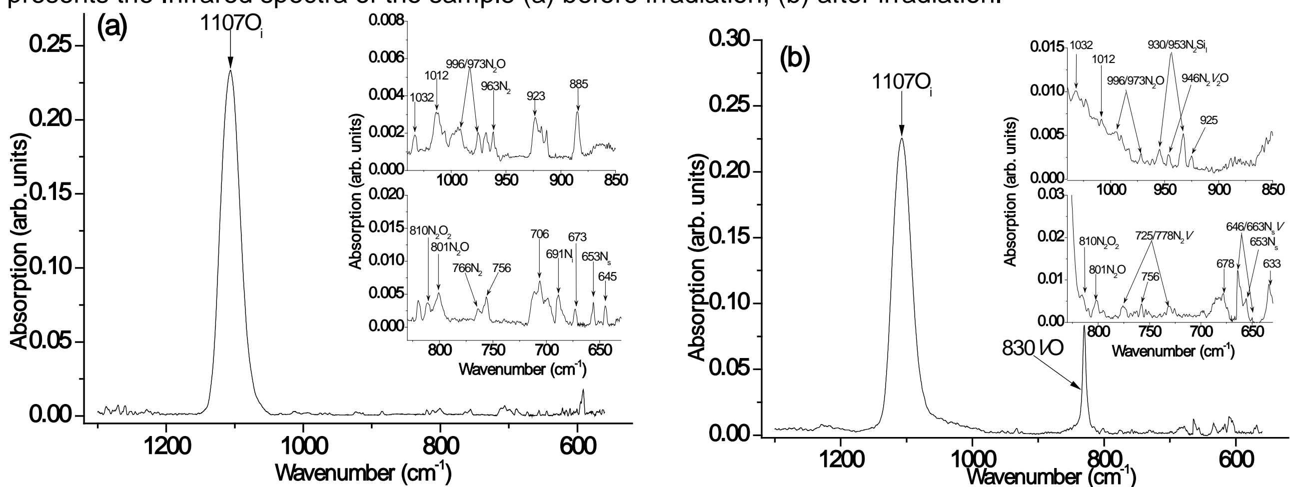

Fig.1 Infrared spectra of the sample (a) before irradiation, (b) after irradiation

Besides the well-known signals of substitutional (N_s) at 653 cm^{-1}, interstitial (N_i) at 691 cm^{-1}, N_2 at 766 cm^{-1}, N-O complexes at 801, 996 and 1026 cm^{-1} and N_2O at 973 and 996 cm^{-1}, two bands at 646 and 663 cm^{-1} were attributed to a N_sV pair, two bands at 725 and 778 cm^{-1} were attributed to the N_2V complex and another pair of bands at 930 and 953 cm^{-1} were attributed to the N_2Si_I complex. Additionally we determined that N doping can reduce the formation of *V*O defects (Fig.2) The limitation of these defects will be beneficial as they can deleteriously impact materials properties and in turn the performance of devices. The evolution with temperature of the VO (830 cm^{-1}) and the VO_2 (888 cm^{-1}) defects of the N-doped and N-free samples.

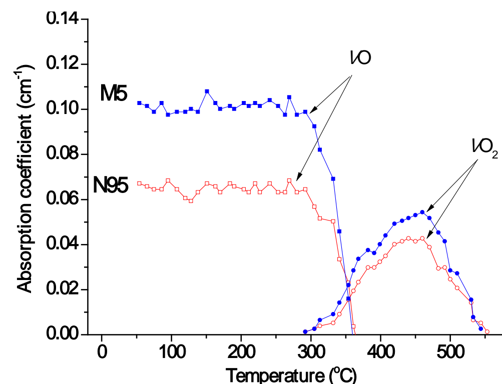

Fig.2 VO and VO_2 evolution with T in N-doped (N_{95}) and N-free (M_5)samples.