Implantation Damage in p-silicon investigated *by* nanocalorimetry technique

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Nanocalorimetry is a promising technique for the study of thermal processes and used successfully to measure the heat involved in a variety of phase change and reactions occurring at the surface of materials: melting point depression for nanostructures [1], glass transition in ultra thin polymer films [2], and the kinetics of damage relaxation in ion implanted a-Si [3]. It operates on the same principle as conventional Differential Scanning Calorimetry (DSC) although on the nanometric scale, making possible the observation of thermal processes implying energies of the order of the nanojoule. The system is based on calorimeters made using LPCVD silicon nitride deposition and usual nanofabrication methods. A thin Si_3N_x membrane (90 nm) supports a platinum strip that can be heated at a rate up to 10^6 K/s (Fig. 1). The high heating rate, combined with the low thermal conductivity of the membrane, minimizes the losses during experiment. The nanocalorimetry experiments are achieved in differential mode to increase the sensitivity.

In this research project, we use nanocalorimetry to investigate, from the thermal point of view, the dynamics of defect induced by low energy ion implantation. In order to measure the effective sensitivity of our system, we have run test experiments on Sn depositions, and have been able to measure a significant melting point depression effect [1]. We are now investigating defect recombination poly-Si. A thin film of poly-Si is deposited on silicon nitride from the backside and has the same width as the platinum strip and a low energy ion implantation of Si is performed at fluences from 6×10^{11} to 8×10^{14} ion/cm^2. Calorimetric measurements are carried out in situ so a high repeatability rate can be achieved. The results show the heat increases monotonically but not linearly with fluences (Fig. 2), and saturates around $1x10^{14}$ ions/cm^2. The similarity of the signal shape obtained at different fluences also tells us that the defect evolution kinetics is independent of the defect concentration.

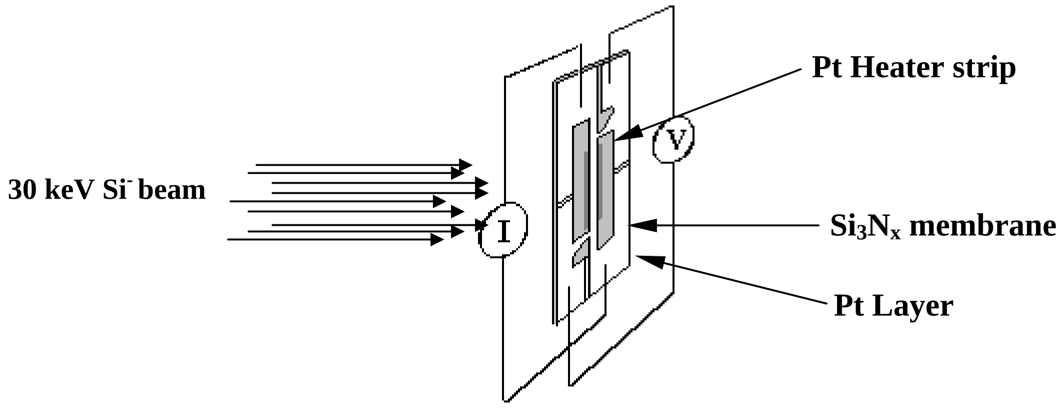

Fig. 1: Schematic of a nanocalorimeter used for the investigations of low-energy ion implantation defect kinetics.

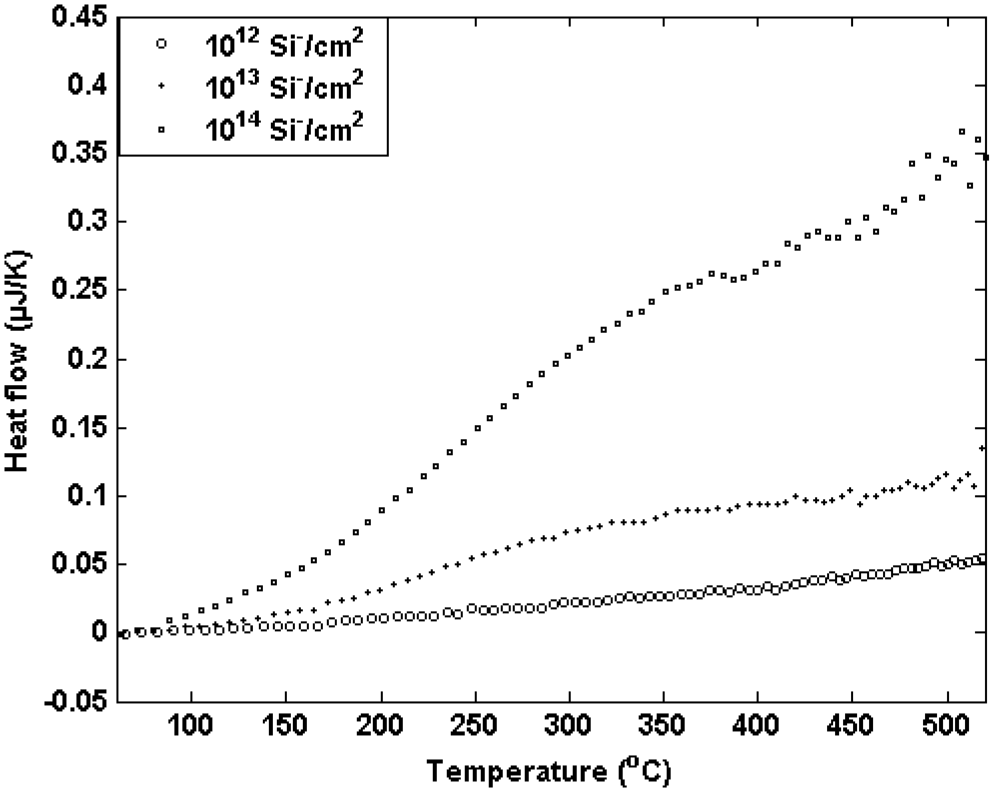

Fig. 2: Heat released by p-Si implanted with 30 keV Si- at indicated fluences.

References:

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