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Current Issues in Heteroepitaxial Growth- Stress Relaxation and Self Assembly

Character of Defects at an Ion Irradiated Buried Thin-Film Interface

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The integration of different materials to create devices on a single chip with multiple functions involving optical, electrical and mechanical interactions is presently a rapidly growing field of interest. The various interfaces and differences in properties such as thermal expansion impose important complications in achieving the required materials integration. Ion implantation provides capability to fine-tune the properties of these integrated structures due to its ability to deposit energy and matter at appropriate positions. In this regard, the consequence of implantation through various interfaces must be understood. In this work, we have studied the effect of ion implantation through a c-Si/SiO_2/c-Si heterostructure. We have performed high-energy ion implantation into such a structure having a 0.2-µm thick SiO_2 layer at a depth of 1.5µm. Using a recently developed technique, Au labeling, we show that besides the expected excess vacancy (V^{ex}) defects in the Si overlayer an additional defect peak occurs at the front side of the buried Si/SiO_2 interface. By injecting additional Si atoms into this region, we determined the defects to be vacancy-type in nature. We have quantitatively studied the interface V^{ex} concentration as a function of Si ion dose. The presence of this V^{ex} peak near the interface is also predicted by the binary collision code TRIM and is related to a discontinuity in the flux of recoiled atoms due to the presence of the Si/SiO_2 interface. Further, we also show using TRIM that the nature of the defects at the interface can be changed from vacancy to interstitial-type by adjusting certain physical characteristics of the buried thin film, such as its density and the atomic masses of its constituents. This result suggests the possibility of using ion beams to selectively modify the strain near interfaces during and after heteroepitaxial growth.

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