Control of swelling height of Si crystal by irradiating Ar beam

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Over the past five decades, ion implantation technique has been performing an important role in the semiconductor industry. In previous studies, it has been found that ion implantation can induce a swelling phenomenon on crystal surface. The swelling effect was understood based on the volume expansion induced by amorphous defects in the irradiated area [1,2]. In this paper, we studied about the control of swelling height by changing fluence and energy of irradiated ion beams. The present results would lead to develop a new fabrication method for nanometer-sized 3D-structures with a simple process.

Ar beams, prepared by ECR ion source installed at Kochi University of Technology [3], were irradiated onto a <100> Si crystal through a stencil mask at room temperature. The ion source can provide a stable and long-time beam. In order to provide the height of the swelling, the surface profile of irradiated samples was observed by using alpha-step IQ surface profiler.

Fig.1. shows the typical surface profile of irradiated Si. In this figure, a step structure due to surface swelling by the amorphous defects is clearly seen. The width of swelling areas (100μm) is consistent with that of a stripe pattern of a stencil mask. The average distance from the level of the un-irradiated area is defined to be the height of swelling. Fig.2 shows the relation between swelling height and fluence of Ar^{1+} beam. As an irradiated fluence increased, the swelling height increased up to about 60 nm. The swelling height was observed as a function of energy of Ar, as well. The height was found to be dependent on energy of Ar beams.

In the present studies, the swelling effect was observed and it was found that the height could be controlled by changing irradiation parameters of Ar beams successfully. The applicability of the swelling effect to the nanometer-sized 3-D will be discussed.

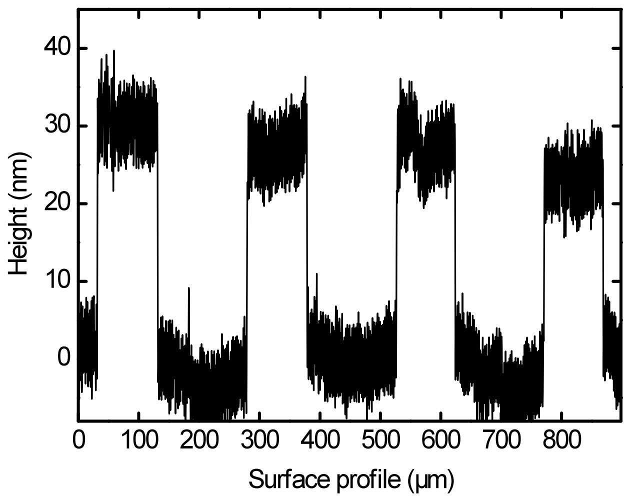

Fig. 1 Surface profile of Si after the irradiation of Ar^{1+} beams with 90 keV and $4\times10^{16}/cm^2$

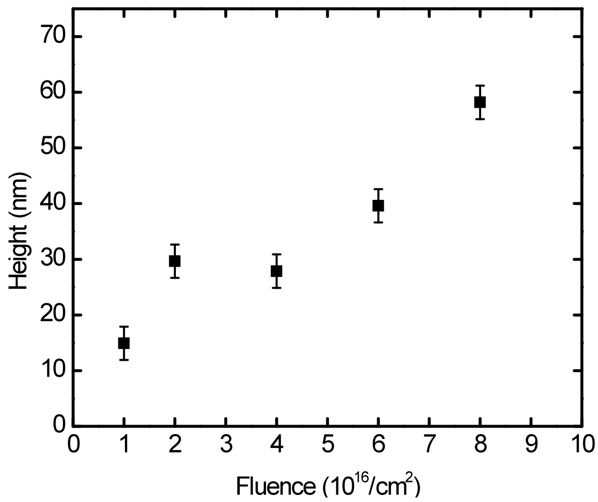

Fig. 2 Relation between swelling height and fluence of Ar beams with 90 keV

References

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