Abstract ID : **267**

Fabrication of swelling structure on SiC surface by using multi-charged Ar beam

Content

Silicon carbide (SiC) crystal, which has good mechanical and electric properties, is one of hopeful materials. Owing to its ultrahigh-hardness and chemical stability, it is difficult to fabricate structures in micro-nano meter scale by means of conventional fabrication processes. Ion beam technology, which has been successfully applied in industrial fields such as semiconductor devices, is a hopeful candidate to solve the problem. In previous experiments, a swelling structure, which is fabricated by means of ion-beam induced expansion effect, has been observed for SiC crystal ([1], [2]). The object of the present study is to show a feasibility of ion-beam induced swelling effect as a fabrication method for SiC crystal. Based on the experimental results, a fabrication of multi-step structure on SiC crystal has been demonstrated.

Ar-beam, which was prepared by ECR ion source (10GHz-NANOGAN), was irradiated on 6H-SiC crystal and a swelling height was observed as a function of the fluence by a profilometer. The swelling height has shown clear relation with irradiation parameters, a fluence and energy of Ar beam. The swelling height has increased with the fluence and reached its saturation value at the fluence of $5x10^{15}$ /cm^2. By using Ar^{7+} beam with 700 keV, the maximum height of 100nm was obtained. Based on those results, two-step irradiation of Ar beam on 6H-SiC was performed. Irradiation parameters and areas of two independent irradiations were different for each other. Two-step structure has been successfully fabricated by the two-step irradiation. In order to confirm the possibility of the swelling structure as mechanical devices, irradiation-induced modification of mechanical properties of SiC crystal was evaluated by means of nano-indentation method. No serious deteriorations have been observed under the present irradiation conditions.

References

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[2] M. Ishimaru, I.T. Bae, A. Hirata, Y. Hirotsu, Phys. Rev. B (2005) 72:024116.

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Track Classification : Applications and related technologies

Contribution Type : Poster presentation

Submitted by **MOMOTA, Sadao** on **Friday 16 June 2017**