Study on ripple or nano pattern formation on Si by low energy Ar^+ ion beam and smoothing of rippled or nano patterned surface

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Fabrication of well ordered nanostructures (ripple, nanodots and nanowires) has received wide attention due to possible applications in optical and electronic device manufacturing. Since the first detection of ripple structures on glass surfaces by Navez et al. ripple formation has been also observed for a number of different materials such as Si, Cu, HOPG and Ag by using low to high energy [1]. However ripple and pattern formation by low energy (<1 kev) Ar ion beam and smotthing of rippled and patterned surface have not yet been reported perfectly. Therefore we have conducted our research on both ripple or nano pattern formation and finally smoothing of rippled or nano patterned surface by low energy ion beam irradiation.

The experiments were conducted in an IBF apparatus which has an ECR discharge type ion source in order to generate Ar+ ion beam in the range of ～1 kV. Si surface was irradiated by Ar^+ ion beam at different incident angle. The surface topography was investigated by atomic force microscope (AFM).

Fig 1 shows successful ripple and nanopattern formation on Si substate by 1keV Ar^+ ion beam at incident angle of (a) 30°, (b) 45° and (c) 70°. It shows at 30° a thin pattern was formed and the size of pattern was increased due to increases of incident angle. Therefore ripple was formed at incident angle of 45° and the shape of ripple changed to sharp and facet ripple at 70°. The reason of such tendency will be discussed and compared with other research.

In second stage, the rippled or nano patterned surface was irradiated by Ar^+ ion beam at 0° ion incident angle (beam direction 1) shown in fig 2(a). The surface was observed by AFM and shown in fig 2(b). It shows surface can be smooth up to 0.11 nm rms if irradiated at 0°.However it may give us different result or pattern if we use different beam direction (beam direction 2 and 3).The results will be discussed too. The potential application of this research will be both in smoothing and nano imprint mould fabrication.

Reference

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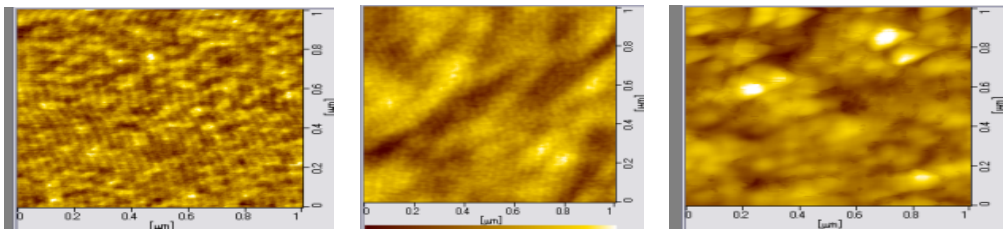
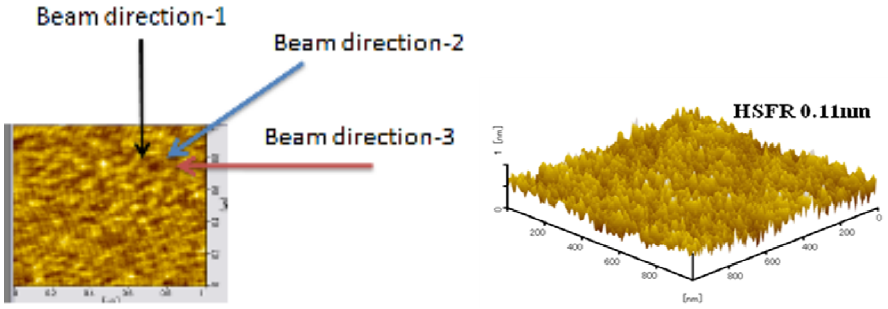


(a) 0.10nm rms at 30° ion incident (b) 0.44nm rms at 45° (c) 1.0nm rams at 70°

Fig. 1. Ripple formation on Si and HSFR value at different ion incidence.



(a) Experimental approach on pattern surface (b) Irradiated surface (beam direction-1)

Fig.2. Smoothing of rippled or nano patterned surface.