Ion beam sharpening of diamond tools having small apex angle without facet and ripple formation

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In the case of sharpening of diamond tools having small apex angle by low energy ion beam, facet formation at the cutting edges become problem [1]. Besides, ripple formation at the cutting face of diamond tools by ion beam bombardment becomes problem. Therefore, in this paper, we have investigated about ion energy dependence of facet angle, and also influence of ion dose, ion beam energy and ion incidence angle on ripple formation. Then, we developed sharpening method of diamond tools having small apex angle without facet and ripple formations. Also, a simulation method has been developed for predicting the profile changes of diamond tools during ion beam machining at fixed tilt angle.

Fig.1 shows a scanning ion microscope (SIM) photograph of a diamond stylus machined with 1.0 keV Ar^+ at ion beam direction parallel to the arrow in the figure. As shown in the figure, facet and ripples were formed.

Fig.2 shows experimental results on ion beam energy dependence of facet angle accompanying with theoretically calculated values. As shown in the figure, facet angle increasing rapidly with increasing ion beam energy as expected from theoretical formula developed by M. J. Witcomb [2]. Therefore, we can control the facet angle by changing ion beam energy. However, coefficient k in the formula is different from those of glass and copper.

Fig.3 shows influence of ion beam energy and ion incidence angle on ripple formation. As shown in the figure, we can obtain smooth surface of diamond tools without ripple formation by sharpening with Ar^+ ion beam of 1-3 keV at ion incidence angle less than 45°.

Fig.4 shows (a) simulated results and (b) sharpened diamond knife. As shown in the figure, the diamond knife was sharpened without facet and ripple formation by setting ion beam energy and direction of ion incidence at adequate values. Moreover, it is concluded that the simulation method is useful for the predicting profile changes of diamond tools.

References:

1 I. Miyamoto, Prec.Eng. **9,** 71 (1987)
2 M. J. Witcomb, J. Appl. Phys, **46**, 11 (1975)

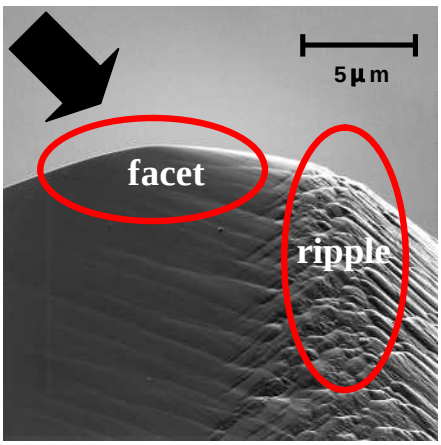


Fig.1 SIM photograph of diamond stylus machined with 1.0 keV Ar^+ ion beam.(The ion beam irradiation was the direction of arrow.)

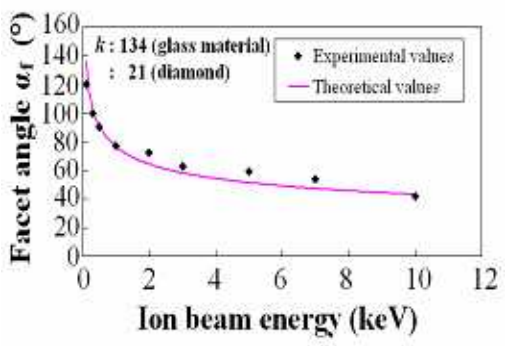


Fig.2 Ion beam energy dependence of facet angle.

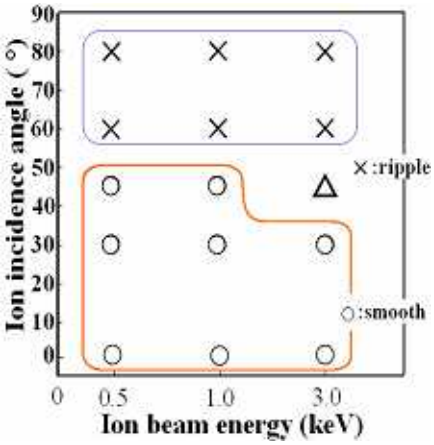
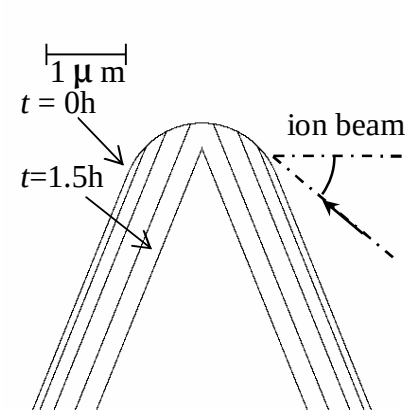
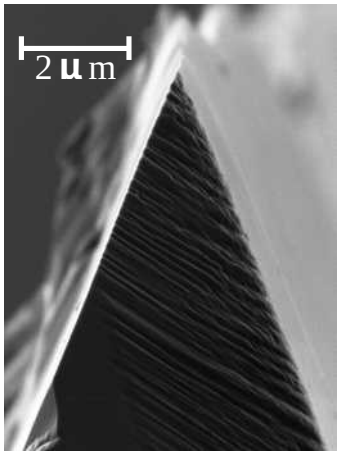


Fig.3 Influence of ion beam energy and ion incidence angle on ripple formation.



(a) Processing method



(b) Processed diamond knife

Fig.4 (a) Processing method, (b) Processed diamond knife irradiating ion beam from the side.