

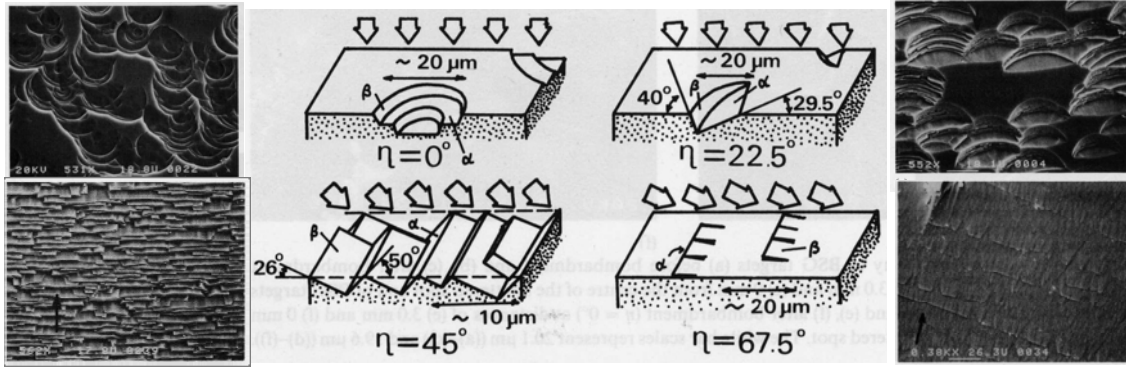


Fig. 1. Scanning electron microscope (SEM) images and corresponding schematic diagrams of erosion patterns caused by normal ($\eta = 0^\circ$) and off-normal ($\eta = 22.5^\circ, 45^\circ, 67.5^\circ$) 4.25 keV Ar^+ ion beam sputter-etching of fused silica targets with initially smooth planar surfaces. The angles of the observed facets in the schematic diagrams were obtained by tilting the sample under SEM observation.

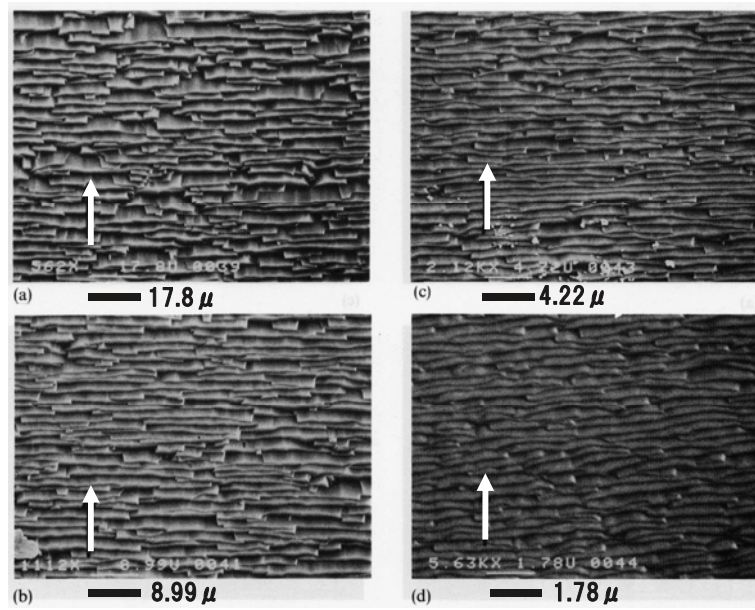


Fig. 2. Coarsening of ripples at $\eta = 45^\circ$ with Ar^+ ion doses J : (a) 0.36 C/cm^2 ; (b) 0.23 C/cm^2 ; (c) 0.14 C/cm^2 ; (d) 0.09 C/cm^2 . The white arrows indicate the azimuthal directions of the ion beam incidence. The black bar scales represent lengths of (a) 17.8 μm , (b) 8.99 μm , (c) 4.22 μm , (d) 1.78 μm , respectively.

for the ripple growth. However, since ion beam irradiated surfaces get high temperature and it promotes surface diffusion of atoms, reduction of concavity and convexity of the surface takes place. This is planarization event (B) for the ripple growth. Therefore, the ripple formation by ion beam sputter-etching shares essential features with the sand ripple formation although redposition of sputtered materials are not taken into consideration.

5. Recent and Future Trend

Figure 6 shows the numbers of annual publications on the ripple formation by ion beam sputter-etching. They are increasing rapidly after 1994. Besides Ar^+ - SiO_2 system (Keller *et al.*, 2009), variety of combinations of ions and target materials such as metals, semiconductors and ionic crystals have been studied. Prevalence of scanning probe microscopy may have contributed to this as well as practical necessity in micro-fabrications and “nano-technology”. For example, in fabrication of artificial nano-scale structures,

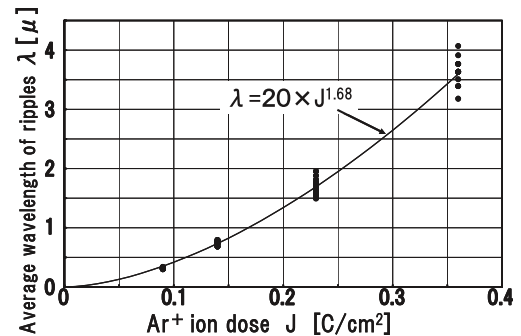


Fig. 3. Plots of measured average wavelength of the ripples λ against Ar^+ ion dose J .

focused ion beam machining plays a key role. However, spontaneous ripple formation can be an obstacle for fabrication of intended fine structures. Therefore, it is important to know the condition to reduce the spontaneous ripple for-