Etching of Electronic or Hard Materials

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It is reported that synchrotron radiation (SR) has stimulated evaporation of SiO_2 using white light from bending magnet. Unlike bending magnet, spectrum from the undulator of SR light is sharp, and the light can be tuned to control chemical reaction. So, etching of electric materials has been studied in BL27SU / CVD experimental station (soft X-rays undulator beamline for photochemistry and CVD).

Soft X-rays from undulator was irradiated to SiO_2/Si samples. Gap width of magnets in the undulator is varied from 40 to 80 mm. Soft X-rays is in the energy range from 304 to 1899 eV, and projection of the photon beam on the sample surface was elliptical with of 5 and 0.5 mm in the radius directions, respectively. The samples were set in vacuum (~5x10^{-6} Pa) or O_2 gas (3x10^{-3} Pa) during the irradiation.

Figure 1 shows the SR stimulated evaporation rate in SiO_2 film as a function of the gap width (emitted photon energy). SR-stimulated evaporation in SiO_2 is clearly observed, and etching rate depends on the gap width. However, this dependency may be caused by the difference of the total photon density, because photon flux from BL27SU undulator had a peak at 70 mm (1290 eV) and 1290 eV is smaller than the absorption edge of Si (79.3 mm, 1844 eV).

The surface reaction was measured by using auger electron spectroscopy (AES). Figure 2 shows the AES spectra of Si substrate with native oxide. This figure shows Si $L_{23}VV$ AES peak at 92 eV indicating elementary Si. Moreover, Si AES peak shift at 76 eV indicating Si-O, decreases on irradiated area. On the other hand, spectra do not change on unirradiated area and 92 eV peak does not observed. This suggests that SR-stimulated evaporation occurs, and surface composition changes to SiO_x ($x < 2$).

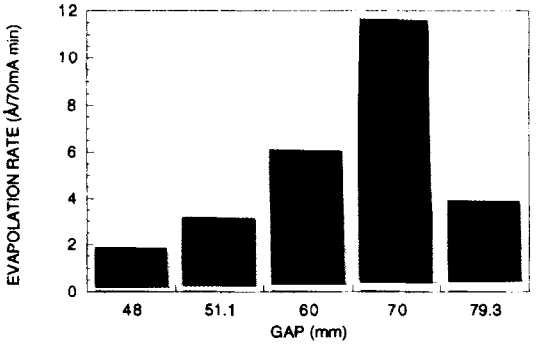

Figure 1: SR-stimulated evaporation rate in SiO_2 film as a function of undulator gap width.

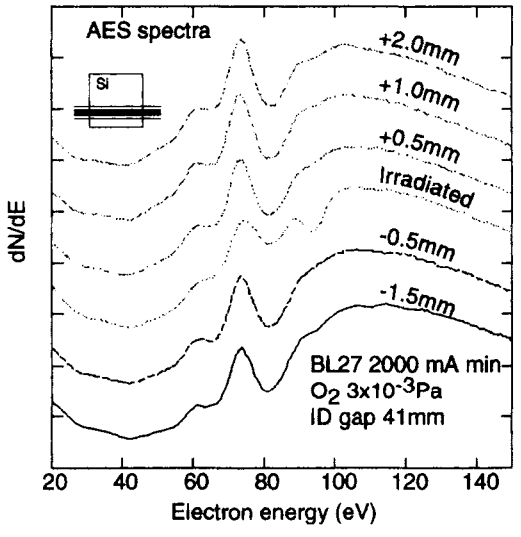

Figure 2: Auger electron spectra of Si with native oxide irradiated with SR.