Photo-Induced Enhancement of Oxidation On p- and n-type Si(001) Surfaces

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The interfacial oxidation rate at SiO_2/Si strongly depends on the SiO_2 thickness. We have proposed “Unified Si oxidation model mediated by point defects“ in previous study[1] to represent the oxidation mechanism in thin SiO_2 films less than 1 nm. It is considered in our model that the point defects (emitted Si atoms and its vacancies) generated by the oxidation induced stress plays as a reaction site of O_2 and Si at the SiO_2/Si interface. In addition, oxidation is “trade” of electron, so we think oxidation rate depends on the type of conductivity (p- or n-Si)[3]. It can be considered these doped electron are excited from valence band by photo-irradiation, and affect oxidation reaction[3]. In this study, the real-time XPS measurements were performed to compare oxidation rate and oxidation-induced strain between on p- and n-type Si(001) surface..

The samples for oxidation were p- and n-Si(001) surfaces. The oxidation and real-time XPS measurements were performed using the surface chemistry station placed at BL23SU, SPring-8, Japan. There samples were oxidized using O2 gas at the pressure of 5×10^{-4} Pa. The XPS measurements were repeated during oxidation. After finishing the oxidation and real-time measurements, the sample was moved 1 mm to measure the spectra at X-ray non-irradiated area (SX-OFF) during the oxidation to clarify the effect of photo irradiation to oxidation.

Figure shows Si 2p spectra on p- and n-Si(001)surface at SX-ON and SX-OFF area after 5h oxidation during XPS measurement. At SX-OFF area, p-Si had faster oxidation rate and larger strain components than n-Si. This can be explained with our oxidation-induced strain model. At SX-ON area, the oxidation ratio on n-Si had faster oxidation rate than that on p-Si. But p-Si had larger strain components. From this result, we found photo-induced electron affected oxidation reaction. In n-Si, oxidation was promoted by photo-irradiation, because n-Si has many doped electron and these electrons were excited from valence band and trapped by the point defects. In my presentation, we’ll also refer to relation of oxidation rate with oxidation-induced strain.

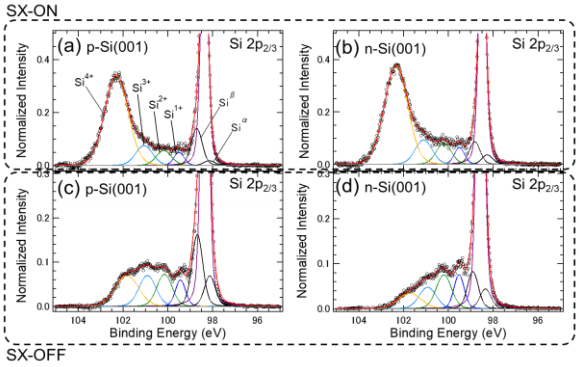

Fig. Si 2p spectrum after 5 hours oxidation (a)p-Si(001) at SX-ON, (b)n-Si(001) at SX-OFF, (c)p-Si(001) at SX-ON, (d)n-Si(001) at SX-OFF

References
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