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Depth analysis of the surface of Mg_2Si crystals with XAS and XPS

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1 Introduction

In order to develop silicon-based electronic devices, metal silicides are widely studied. Information of the surface chemical states of metal silicides is important to obtain homo-epitaxial films with excellent quality. X-ray photoelectron spectroscopy (XPS) is commonly used to elucidate surface chemical states of solids. Here, non-destructive depth analysis is possible by changing excitation X-ray energy [1,2]. However, peak assignments in XPS are often difficult due to insufficient chemical shifts. In this case, the analysis with X-ray absorption spectroscopy (XAS) would give useful information on the peak assignments.

In this work, depth analysis of surface chemical states of Mg_2Si crystals is carried by XPS. Depth analysis is also performed in XAS measurement with total electron yield (T.E.Y.) and partial electron yield (P.E.Y.) modes.

2 Experiment

The Mg_2Si crystals were prepared from Mg_2Si ingots grown by a modified vertical Bridgman method [3]. The cleaved surface of the Mg_2Si crystal was measured with XPS and XAS. The measurement was performed at the beam line 27A. In the XPS measurements, excitation energies ranging from 2100 to 3300 eV were used. The Si K-edge XAS spectra were obtained with T.E.Y. and P.E.Y. modes.

3 Results and Discussion

The Si 1s XPS spectra of the cleaved surface of the Mg_2Si crystal measured with the excitation energies of 2100 and 3300 eV show significant change as shown in Fig. 1. The peak at 1836.8 eV is dominant in the spectrum measured with the energy of 3300 eV, which is assigned to Mg_2Si structure. In contrast, The peak (1841.4 eV) attributed to SiO structure is dominant in the spectrum measured with the energy of 2100 eV. The use of the lower excitation energy enables us to obtain information on shallower surface. Therefore, the result indicates that SiO is formed on the surface of the Mg_2Si crystal. Here, no peak assigned to SiO_2 structure is observed in Fig. 1.

Figure 2 shows the Si K-edge XAS spectra of the cleaved surface of the Mg_2Si crystal. In the spectrum obtained with the P.E.Y. mode, a peak at 1843.7 eV is dominant, compared to the spectrum obtained with T.E.Y. mode. The peak can be assigned to SiO structure. Since the electrons with the energy of around 50 eV were obtained in this measurement, the P.E.Y. spectrum gives the information on shallower region of the Mg_2Si surface. Therefore, Fig. 2 indicates the formation of SiO on the surface of the Mg_2Si crystal, which is consistent with that of XPS analysis.

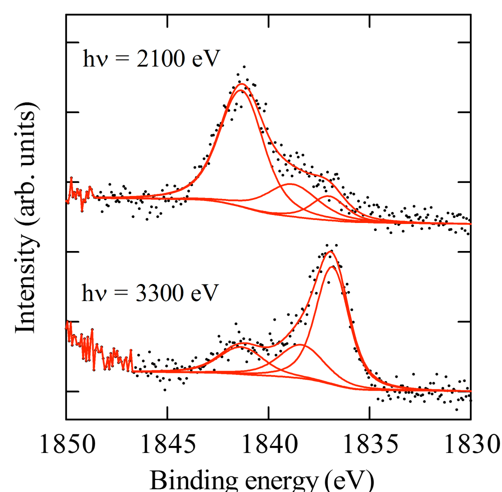

Fig. 1: Si 1s XPS spectra of a $M_{g2}Si$ crystal measured with the excitation X-ray energies of 2100 and 3300 eV.

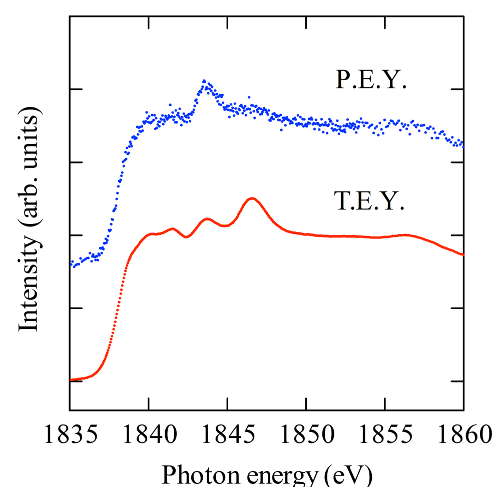

Fig. 2: Si K-edge XAS spectra of a $M_{g2}Si$ crystal obtained with P.E.Y. and T.E.Y. modes.

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