Core-Level Photoemission of Mn_3Sn

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Intermetallic compound Mn_3Sn has been attracting much interest not only due to its peculiar magnetic structures but also because of its possible application as anomalous Hall effect material [1].

It is known that core-level photoemission of magnetic element is useful because it reflects the difference in the electronic states of the magnetic element in different magnetic compounds. We have studied Mn_3Sn by means of Mn 2p core-level photoemission (Mn 2p XPS).

The XPS measurements were carried out at SA-1 of SR Center in Ritsumeikan University using the scanning soft and hard X-Ray photoemission apparatus (SX&HX-ESCA). Soft X-ray photoemission was performed by monochromatized Al K α emission (1486.7 eV) to measure the surface of the sample. Hard X-ray photoemission was performed by monochromatized Cr K α emission (5414.7 eV) to measure the bulk. To avoid the influence of oxidation, the sample was fractured in vacuum and measured without exposing it to air.

Figure 1 shows the result of Mn 2p XPS. The overall spectrum is characterized by a two-peak structure coming from the Mn $2p_{1/2}$ and $2p_{3/2}$ core-levels, where the splitting is due to the spin-orbit coupling of the 2p electros. In the $2p_{3/2}$ component of the spectrum measured by Al K α emission, the peak top is found at 638.4 eV, a structure is found at 639.1 eV and a broad hump is found between 640 and 645 eV. The $2p_{1/2}$ component shows a single-peak structure located at 650 eV and a hump between 652 and 655 eV. In the spectrum measured by Cr K α emission, the 639.1-eV structure seen in the Al K α spectrum is not seen.

In order to investigate the difference between surface and bulk, we compare the Al K α and the Cr K α spectra. Since the energy resolution is different between the two spectra, we broaden the Al K α spectrum using Gauss function and compare the two spectra in the bottom panel of Fig. 1. The line shape between 637.5 and 640 eV near the $2p_{3/2}$ peak is essentially the same between the broadened Al K α spectrum and the Cr K α spectrum. Therefore, the double peak structure near the $2p_{3/2}$ peak seen in the Al K α is possibly present in the bulk. On the other hand, the broad hump between 640 and 645 eV is relatively larger in the Al K α spectrum than in the Cr K α spectrum. Therefore, this hump is expected to be coming from the oxidized layer near the surface.

We now compare the present Mn 2p spectrum with that of pure Mn. The $2p_{3/2}$ peak of pure Mn located at 638.7 eV shows a single-peak structure unlike the present spectrum of Mn_3Sn where two structures are located at 638.4 and 639.1 eV. One might interpret that the 638.7-eV peak of pure Mn is split to 638.4 eV and 639.1 eV in Mn_3Sn. This difference between pure Mn and Mn_3Sn may reflect the difference in the magnetic moment of Mn atom in these materials.

References

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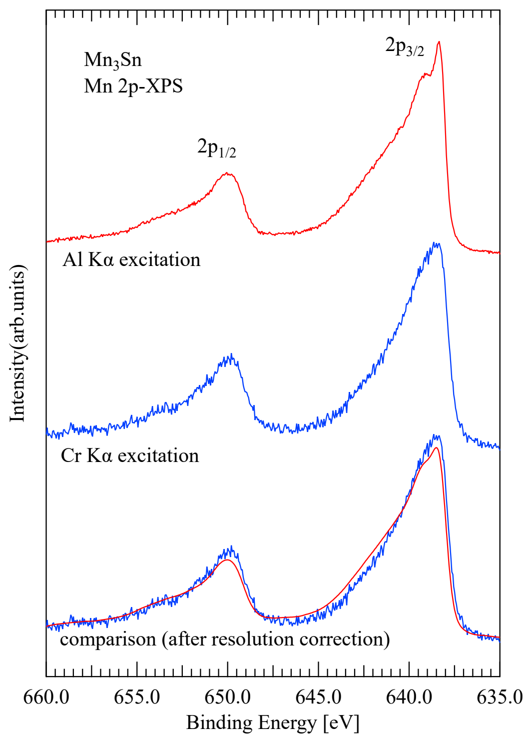

Fig. 1 Mn 2p photoemission of Mn_3Sn measured by Al K α and Cr K α emissions (top and middle). Shirley-type background is subtracted [2, 3]. At the bottom, the Al K α spectrum is broadened using Gauss function with FWHM of 0.5 eV to correct the difference of the resolution.