Effect of Addition of Co to the Ni-Mn-Sb Heusler Alloy on Electronic State

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Off-stoichiometric NiMn-based Heusler alloys were reported to be a new type of metamagnetic shape memory alloy [1]. With increasing Co composition in B2-type $Ni_{50-x}Co_xMn_{50-y}Al_y$ (y ~ 18), the magnetic property of the austenite phase changes from paramagnetic to ferromagnetic while the magnetization in the martensite phase slightly decreased [2]. The addition of Co is considered useful to obtain metamagnetism. In this study, we used X-ray photoelectron spectroscopy (XPS) to observe the inner shell electron spectra of $Ni_{50}Mn_{36.5}Sb_{13.5}$ and $Ni_{45}Co_5Mn_{38}Sb_{12}$, in order to investigate the effect of adding Co to these Heusler alloy on electronic state.

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 Al Kα emission (1486.7 eV) to measure the surface of samples. Hard X-ray photoemission was performed by Cr Kα emission (5414.7 eV) to measure the bulk of samples. To avoid the influence of oxidation, samples were fractured in vacuum and measured at the fracture surface. We measured Ni 2p, Co 2p, Mn 2p and Sb 3d at room temperature, at which the samples are both in austenite phase.

The effect of the addition of Co at Mn 2p is obvious while, for other orbits, difference between two samples is less obvious. Fig. 1 shows Mn 2p XPS spectra measured at the surface of two samples. When adjusting peaks of Ni LMM Auger to the same height, Mn 2p peak of $Ni_{45}Co_5Mn_{38}Sb_{12}$ is higher than $Ni_{50}Mn_{36.5}Sb_{13.5}$ because of the difference in the composition ratio between Mn and Ni. Fig. 2 shows Mn 2p XPS spectra measured at the bulk of two samples. Here is no Ni LMM Auger. It is obvious that Mn $2p_{3/2}$ is split, both Mn $2p_{3/2}$ and Mn $2p_{1/2}$ peak of $Ni_{45}Co_5Mn_{38}Sb_{12}$ have narrower width than $Ni_{50}Mn_{36.5}Sb_{13.5}$ in the high energy side.

Difference between Mn $2p_{3/2}$ of two samples needs more study to explain. It is possibly related to the different Mn-Mn magnetic coupling. It has been considered that the direction of the Mn magnetic moments at the Sb site and at the ordinary site changes from antiferromagnetic coupling to ferromagnetic coupling by adding Co [3].

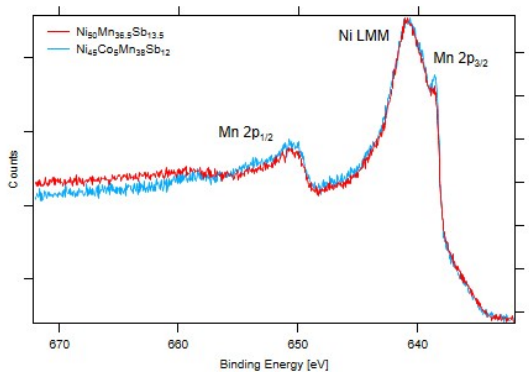

Fig. 1 Mn 2p XPS spectra measured in the surface of two samples by Al Kα.

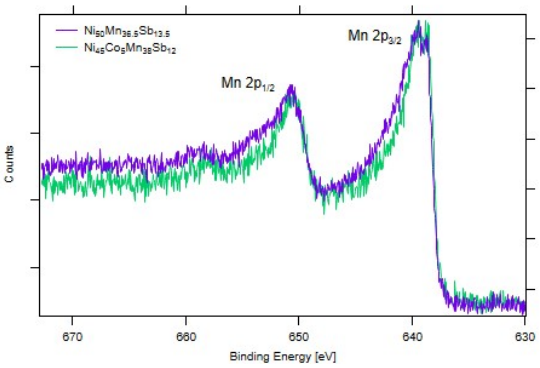

Fig. 2 Mn 2p XPS spectra measured in the bulk of two samples by Cr Kα.

References

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