Angle-resolved photoemission study of ordered $CoPt_3$(001)

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It is well known that ordered transition metal (TM)-platinum alloys show various magnetic properties. For example, the magnetic structure varies among MPt_3 (M=V, Cr, Mn, Fe and Co) as shown in Table. I. In order to clarify the origin of the variety of the magnetic structures, their electronic structures should be understood. Among them, $CoPt_3$ forms cubic $L1_2$ structure and ferromagnetic structure below a Curie temperature of 290K. In this report, we have successfully obtained 1x1 clean surface of the single crystalline $CoPt_3$(001) and performed an angle resolved ultraviolet photoemission spectroscopy (ARUPS). The experiment was carried out at BL-18A of Photon Factory, KEK. The clean surface was obtained by the repeated cycles of Ar ion bombardment and annealing up to 510K, which is below the critical temperature of the order-disorder structural phase transition. Sharp 1x1 LEED pattern was obtained after the procedure as shown in Fig.1. The ARUPES spectra were taken at the photon energy ($h\nu$) of 20-150eV with a normal emission configuration. Here, the normal emission spectra represent the electronic states along Γ-X-Γ direction in the cubic Brillouin zone.

	VPt_3	$CrPt_3$	$MnPt_3$	$FePt_3$	$CoPt_3$
magnetic structure	Ferri	Ferri	Ferro	Antiferro	Ferro

Table I. Magnetic structures of MPt_3 alloys (M=V, Cr, Mn, Fe, Co).

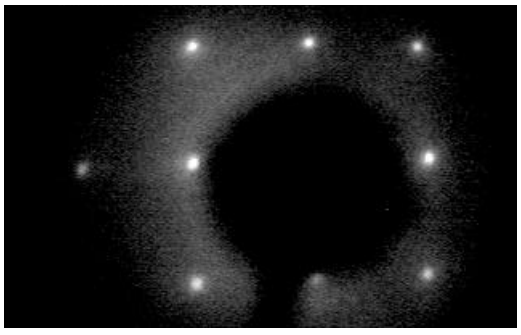

Fig.1. LEED pattern of the $CoPt_3$(001) surface.

The angle integrated photoemission spectra are measured for $h\nu$=46-130eV (*not shown*). It is known that the photo-ionization cross section of Pt 5d state is several times larger than that of Co 3d state for the photon energy range of 20-60eV, wheras the cross section of Pt 5d state drops dramatically around $h\nu$=100eV (Cooper-minimum). The angle-integrated photoemission spectrum at $h\nu$=46eV (Pt 5d) shows the structures at E_B=0.3, 2.6, 5.5eV. The structure near E_F grows with increasing photon energy up to 130eV, where the photo-ionization cross section of the Co 3d state is more than 10 times larger than that of the Pt 5d state. The band structure calculation shows that the Pt 5d state is spread over a wide energy from E_F to 7eV, which is consistent with our experimental result at $h\nu$=46eV, for example. Comparing with the results of the band structure calculation, the observed sharp structure of the spectrum taken at $h\nu$=130eV can be assigned to the Co 3d minority spin state. The angle resolved spectrum taken at $h\nu$=46eV shows the structures at E_B=0.3, 2.5 and 5.5eV as shown in Fig.2. The small sharp structure observed just below E_F diminishes for the spectra taken at $h\nu$ above 60 eV. The other structures at 2.5 and 5.5 eV does not show a remarkable dispersion. Such a dispersion-less feature will be discussed in a forthcoming paper. To clarify the spin dependent feature of the experimental band structure, the spin- and angle- resolved photoemission spectroscopy will be performed in near future.

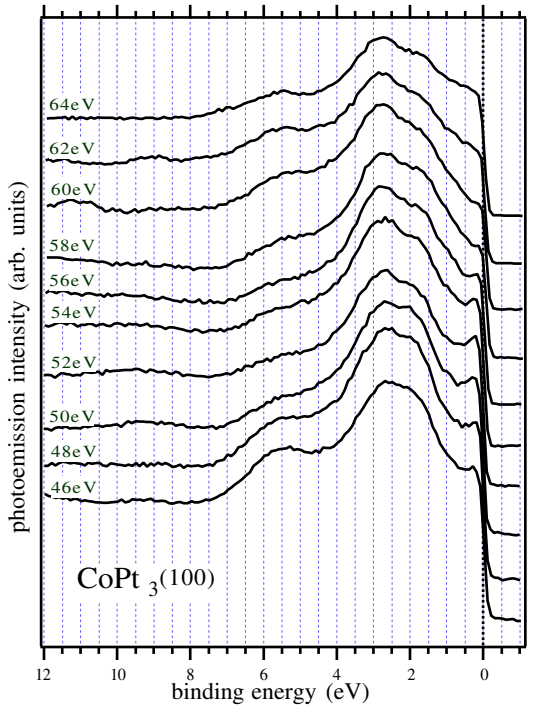

Fig.2 Angle-resolved photoemission spectra of $CoPt_3$(001) for $h\nu$=46-64eV.

References

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