Supplementary information

Simultaneously improved electrical properties of crystalline $YbAl_3$ thin films prepared by co-sputtering technique

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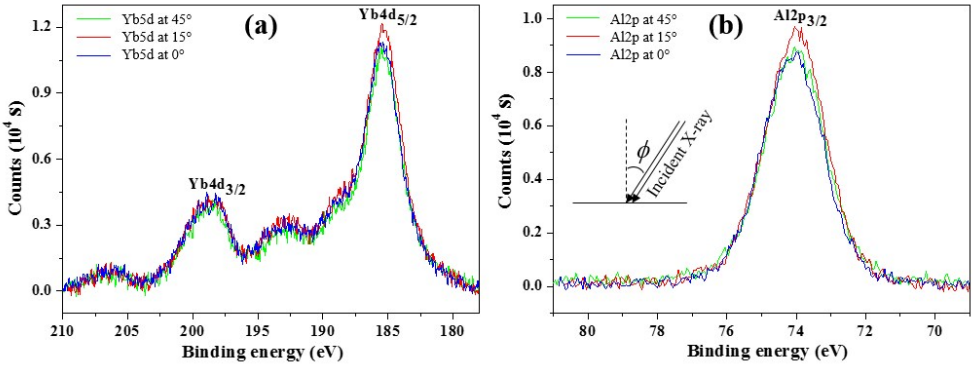
X-ray photoelectron spectroscopy (XPS) was used to confirm the composition variation along the film thickness. The collection of valence-band spectra was performed on a model VG Thermo Multilab 2000 X-ray photoelectron spectrometer, using a monochromatic Al Kα line with a photon energy of 1486.6 eV and a 180 hemispherical analyzer in a constant-resolution mode with a pass energy of 25 eV. The energy resolution was determined to be 0.6 eV based on the analysis of the Ag Fermi edge. The energy step size and spot size were kept at 0.05 eV and OFF. By inclining the incident X-ray beam at different angles from 0° to 45°, the compositions along the different detection depths can be evaluated. The results are plotted in Figure S1. It can be seen that the core-level spectra of $Yb4d_{5/2}$ peak at about 185.5 eV, indicating a chemical valence of Yb^{3+}.[1] With increasing the degree of incident X-ray beam from 0° to 45°, the relative content of Al increases while that of Yb decreased gradually. Although the detection depth of XPS is limited in less than 20 nm just below the surface, these results suggest a continuous decrease of Al along the thickness. The tendency is consistent with our EPMA results. Note that the Al contents measured by XPS are much higher than the EPMA results, which can be attributed to the contribution of the precipitated Al bulges on the surface.



(c)

	Yb 5d			Al 2p		
ϕ	FWHM (eV)	area (CPS·eV)	at%	FWHM (eV)	area (CPS·eV)	at%
0°	3.54	88660	14.5	1.99	20724	85.5
15°	3.49	92090	13.8	1.85	22734	86.2
45°	3.52	83085	12.8	2.02	22281	87.2

Figure S1. Yb5d and Al 2p core-level XPS spectra gained by inclining the incident X-ray beam at different incident angles from 0° to 45° (as simply illustrated in the inset). All the spectra have been numerical treated with background removing.

[1] Thompson AC, Vaughan D. X-ray data booklet, Lawrence Berkeley laboratory. Berkeley: University of California; 1986.