課題番号　：　F-21-IT-024
利用形態　：　機器利用
利用課題名（日本語）　：　トポロジカルハーフホイスラ合金のスピンホール効果に関する研究
Program Title (English)　：　Study of spin Hall effect in topological half-Heusler alloy
利用者名（日本語）　：　白倉孝典, ファム　ナムハイ
Username (English)　：　Takanori Shirokura, Pham Nam Hai
所属名（日本語）　：　東京工業大学
Affiliation (English)　：　Tokyo Institute of Technology
キーワード／Keyword　：　spin Hall effect, 形状・形態観察

1. 概要（Summary）

Topological materials, such as topological insulators (TIs), have great potential for ultralow power spintronic devices, thanks to their giant spin Hall effect. However, the giant spin Hall angle (θ_{SH} > 1) is limited to a few chalcogenide TIs with toxic elements and low melting points, making them challenging for device integration during the silicon Back-End-of-Line (BEOL) process. Here, we show that by using a half-Heusler alloy topological semi-metal (HHA-TSM), YPtBi, it is possible to achieve both a giant θ_{SH} > 1 and a high thermal budget up to 600°C.

2. 実験（Experimental）

【利用した主な装置】

触診式段差計

【実験方法】

We grew YPtBi thin films on c-sapphire substrate by co-sputtering multi targets. We evaluated the spin Hall effect of YPtBi by the second harmonic Hall measurements using Pt/Co/Pt trilayers as the ferromagnet.

3. 結果と考察（Results and Discussion）

Figure 1(a) shows the X-ray diffraction (XRD) θ-2θ spectra for YPtBi films deposited at different substrate temperature T_S ranging from 300°C to 800°C and the Ar pressure of 2.0 Pa. Clear YPtBi(111) peaks were observed at T_S = 300°C ~ 600°C, indicating that YPtBi is stable up to 600°C. Figure 1(b) shows the XRD spectra for YPtBi films deposited at different Ar pressure ranging from 0.3 to 2.0 Pa at T_S = 600°C. Peaks of YPtBi(111) were observed under the whole Ar pressure range. Fig. 1(c) shows an X-ray fluorescence spectroscopy (XRF) spectrum of the YPtBi thin film deposited at T_S = 600°C. The atomic composition Y:Pt:Bi of this sample is close to 1:1:1. Figure 1(d) shows the relative atomic composition of Bi as a function of T_S. which reveals that YPtBi is stable up to 600°C. These results demonstrate that YPtBi has a large thermal budget for the BEOL process.

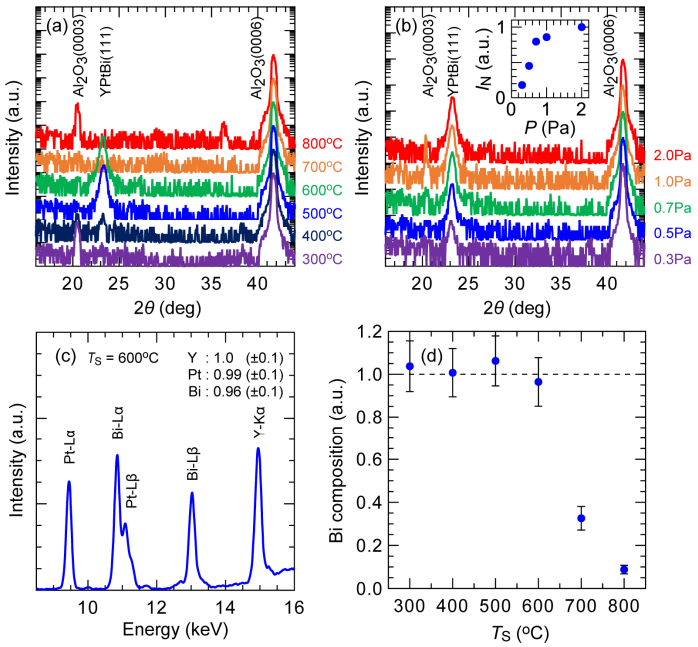

Fig. 1. Crystal structure analysis of YPtBi thin films. (a) XRD spectra of 50 nm-thick YPtBi films deposited on c-sapphire at different substrate temperature. (b) XRD spectra of YPtBi films deposited at different Ar pressure. Inset shows the peak intensity of YPtBi(111) normalized by that at 2.0 Pa as a function of Ar pressure. (c) XRF spectrum of an YPtBi thin film. (d) Bi composition at different substrate temperature.

Furthermore, we observed that YPtBi shows a spin Hall angle larger than 1 from second harmonic measurements.

4. その他・特記事項（Others）

This work is supported by Kioxia corporation.

5. 論文・学会発表（Publication/Presentation）

NA

6. 関連特許（Patent）

特許出願済み