論文 / 著書情報
Article / Book Information

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Title(English)	Interface Structure and Magnetic Properties of BiFeO3-based Layered Films
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（博士課程）
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論 文 要 旨

THESIS SUMMARY

専攻： Department of	材料物理科学　専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of　（　工学　）
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Interface structure and magnetic properties of $BiFeO_3$-based layered films have been investigated. $BiFeO_3$ is the only room temperature sing-phase multiferroic material discovered at present and has a promising application in new generation devices. Chapter 1 describes background information and current research situation of $BiFeO_3$. Chapter 2 and 3 focus on the structure characterization of $BiFeO_3$ films prepared on various substrate (amorphous SiO_2, single crystal MgO and $SrTiO_3$ substrates) and conductive under layer (TiN film). Chapter 4 and 5 report interface induced magnetic properties of $BiFeO_3/L1_0$ ordered $Co_{0.5}Pt_{0.5}$ and $Co_2FeSi/BiFeO_3$ layered films, respectively. Chapter 6 is the final conclusion of this thesis.

In chapter 2, $BiFeO_3$ films are prepared on three typical substrates by sputtering method. No pure crystal $BiFeO_3$ phase can be obtained on amorphous SiO_2 substrates, while crystal $BiFeO_3$ films are grown on single crystal substrates. On MgO substrates, which provides a large tensile strain (~ 6.6 %), $BiFeO_3$ shows three growth orientations: (001), (110) and (111). And $BiFeO_3$ film displays epitaxial growth on $SrTiO_3$ substrates, which imposes a relatively small compressive strain (~ - 1.4 %). Such differences indicates $BiFeO_3$ film growth is quite sensitive to substrates.

Chapter 3 explores $BiFeO_3$ film growth on TiN under layers. Three substrates are used: amorphous SiO_2, MgO (001) and MgO (111) substrates. TiN under layers show (111) orientation on amorphous SiO_2 and MgO (111) substrates, and no crystalline $BiFeO_3$ phase can be induced on (111)-textured TiN under layers. On the other hand, (001) TiN film is grown on MgO (001) substrates and crystalline $BiFeO_3$ films are obtained on (001) TiN under layers. This can be understood from stability difference between (001) and (111) surface. Compared to (001), (111) surface of $BiFeO_3$ are energetically unfavourable, and (111) TiN cannot trigger the nucleation of $BiFeO_3$ phase. Besides, epitaxial $BiFeO_3$ growth can be prepared on TiN (001) under layers at reduced deposition temperature of 500 °C. At this condition, two kinds of structure co-exist: tetragonal (T) and rhombohedral (R). The crystallographic relationship can be expressed as: T-$BiFeO_3$ (001)[100]//TiN (001)[100] and R-$BiFeO_3$ (001)[100]//TiN (001)[100].

Magnetic properties in perpendicular direction of $BiFeO_3/L1_0$ ordered CoPt films are reported in chapter 4. The layered films exhibit epitaxial growth confirmed by both XRD and TEM results. As for magnetic characterization, mainly three results are observed. First of all, existence of $BiFeO_3$ film can enhance perpendicular anisotropy. The single ordered CoPt film shows isotropy due to low ordering degree, and perpendicular anisotropy is enhanced with $K \sim 1.9*10^6$ erg/cm^3 by further depositing $BiFeO_3$ on the top of CoPt films. Secondly, perpendicular exchange bias effect is detected at 50 K in $BiFeO_3/Pt/L1_0$ CoPt layered structures. The coercivity H_C value is 5522 Oe and loop shift H_E value is – 646 Oe. Thirdly, a magnetic field-mediated magnetic states phenomenon in perpendicular direction is observed in $BiFeO_{3\ 30nm}/Pt_{0.5nm}/L1_0$ ordered $CoPt_{10nm}$ structures. Two different hysteresis loops (two magnetization steps with plateau and non-plateau shapes) can be repeatedly switched by orthogonal external magnetic field. This phenomenon is induced by different responds to external field of each layer (that is Co-containing $BiFeO_3$, Co-deficient CoPt and $L1_0$ ordered CoPt layers) in layered architecture, which is suggested by Co segregation distribution in the cross-section element mapping image.

Chapter 5 describes longitudinal exchange bias effect in $Co_2FeSi/Pt/BiFeO_3$ layered films. An ultra-thin Pt layer (0.5 – 2 nm) is inserted between Co_2FeSi and $BiFeO_3$ films. The existence of Pt layer can prevent oxidization of Co_2FeSi, confirmed by both M_S value in hysteresis loops and Auger electron spectroscopy depth profile. After field-cooling treatment, the coercivity H_C value increases compared to that of as-deposited films, indicating the exchange bias effect. The highest H_C enlargement (from 20 to 80 Oe) happens at $Co_2FeSi/Pt_{0.5nm}/BiFeO_3$ films. However this sample does not show loop shift (another manifestation of exchange bias effect) at room temperature. This may be due to relatively large thickness of Co_2FeSi (6 nm) explained by random-field model.

In all, interface structure and magnetic properties of $BiFeO_3$/TiN, $BiFeO_3/L1_0$ CoPt, Co_2FeSi/Pt/CoPt layered films are studied, respectively. Epitaxial $BiFeO_3$ films are prepared on conductive TiN under layers at reduced temperature ~ 500 °C. Perpendicular exchange bias effect and field-mediated magnetic states phenomenon are detected in $BiFeO_3/L1_0$ CoPt layered films. Longitudinal exchange bias effect is observed in $Co_2FeSi/BiFeO_3$ layered films.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).