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論文 / 著書情報
Article / Book Information

題目(和文)	VO2薄膜およびVO2と磁性金属の層状構造の作製
Title(English)	Fabrication of VO2 films and VO2-based magnetic layered structures
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学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

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（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

系・コース： Department of, Graduate major in	材料 材料	系 コース	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of （ 工学 ）
学生氏名： Student's Name	QIU SUIYU		指導教員（主）： Academic Supervisor(main)	史蹟
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

The VO_2 films are successfully prepared on the glass substrates by the two-step method, i.e., magnetron sputtering of vanadium at room temperature in the Ar+O_2 mixture gas and followed by in-situ annealing in the Ar+O_2 mixture gas. Based on the VO_2 films with the good structure and characteristics, the CoPt/VO_2 bilayer and CoPt/VO_2/Pt/CoPt/Pt multilayer films are prepared on the glass substrates. The X-ray diffraction (XRD) is used to analyze the structures of these films. The Raman spectra is used to analyze the structures of the VO_2 films. The temperature-dependent resistances (R-T curves) of the VO_2 films and the CoPt/VO_2 bilayer films are measured by the four-probe method. The hysteresis loops of the CoPt/VO_2 bilayer films and the CoPt/VO_2/Pt/CoPt/Pt multilayer films are measured by VSM at room temperature. The Hall resistances of the CoPt/VO_2 bilayer and CoPt/VO_2/Pt/CoPt/Pt multilayer films are measured by Van der Pauw method as a function of the temperature.

To fabricate the high-quality VO_2 films, firstly, the films are deposit at room temperature on the glass substrates in the Ar+O_2 mixture gas with the 2.09% oxygen ratio by DC magnetron sputtering. Then the as-deposited films are in-situ annealed at 550 ℃ for 1 hour in the 0.6-10 Pa 80% Ar+20% O_2 mixture gas. The VO_2 films have the monoclinic (M1) VO_2[011] orientation in the film growth direction at room temperature and show the good phase transition characteristics. The preparation conditions, including the in-situ annealing temperature, the in-situ annealing atmosphere pressure, the film thickness and the oxygen content in the as-deposited film, affect the formation of the VO_2 films. These preparation conditions are interrelated and mutually restricted. By adjusting the preparation conditions, the components of the fabricated films could be α-V_2O_5, β-V_2O_5, VO_2 M1 (-111) and VO_2 M1 (020).

For the CoPt/VO_2 bilayer films, as the CoPt layer thickness increases from 3 nm to 8 nm, the easy magnetization axis of the CoPt layer changes from the out-of-plane direction to the in-plane direction. The bilayer films with the 3 nm thick CoPt layer shows the PMA characteristics. The mechanism might be a comprehensive effects of the tensile strain, the interface anisotropy and the electron orbital hybridization between Co and O. Although the VO_2 layer is in contact with the metallic CoPt layer, the total resistivity of the bilayer films still exhibits the thermal hysteresis loop in the R-T curve due to the VO_2 metal-insulator phase transition. For the bilayer films with the PMA, the anomalous Hall effect (AHE) is observed when the magnetic field is applied in the out-of-plane direction. When the bilayer film is heated, the Hall resistance initially decreases with increasing temperature and then reaches a stable value due to the VO_2 phase transition. For the 1.5nm-CoPt/120nm-VO_2 bilayer film, the VO_2 layer plays a role of the switch to control the AHE signal of the bilayer films by its metal-insulator phase transition.

For the CoPt/VO_2/Pt/CoPt/Pt multilayer films, the top 1.5 nm thick CoPt layer exhibits the PMA but the bottom 3 nm thick CoPt layer shows the isotropic magnetic characteristic in the in-plane and out-of-plane directions. When the magnetic field is applied in the out-of-plane direction at room temperature decreased from the saturated value, the magnetic moments in the bottom CoPt layer rotate firstly. After the moments completely rotated, the magnetic moments in the top CoPt layer start to rotate and the magnetization reaches reverse saturation with increasing the magnetic field in the opposite direction. Therefore, the steps are shown in the hysteresis loop and the AHE resistance Rxy vs H⊥ curve. The double flips in the VSM results mean that the magnetic moments in the two ferromagnetic layers are decoupled due to the thick VO_2 layer between them and rotate independently with the applied magnetic field. At high temperature, the step may disappear dependent on the interaction between the top CoPt layer and the VO_2 layer. For the multilayer film with the VO_2 layer in-situ annealed in 1 Pa, the VO_2 layer cannot maintain the strong PMA in the top CoPt layer and smaller coercivity of the top CoPt layer compare with the saturated field of

bottom CoPt layer results in the disappearance of the step at high temperature. For the multilayer film with the VO_2 layer in-situ annealed in 5 Pa, the PMA in the top CoPt layer is strong enough and the step is still maintained at high temperature. The AHE resistance Rxy vs H⊥ curves of the multilayer films can be controlled by applying the large current flowing through the multilayer films because the Joule heat generated by the current heats the multilayer films, promoting the VO_2 metal-insulator phase transition.

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).

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