課題番号 :F-19-NM-0101
利用形態 :機器利用
利用課題名(日本語) :
ProgramTitle(English) :Multiferroic effects in iPCM
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1. 概要(Summary)

New three-terminal iPCM device type was fabricated. Various architectures were tested with the use of different combinations of metal contacts, chalcogenide superlattice structures, including periodicity, thickness. The effect of the external magnetic field was studied. It was found out that the there is no relationship between the direction of the magnetic field and the switching voltage threshold as well as the resistance levels. The resistance of the programmable area of the device was shown to be able to be manipulated by the combination of the contacts usage (bottom, top, and the middle one). Three-terminal iPCM devices was proposed, fabricate and optimized.

2. 実験(Experimental)

【利用した主な装置】
100kV 電子ビーム描画装置
125kV 電子ビーム描画装置
【実験方法】

The electron-beam lithography was used for patterning the sample structures for their further use in the fabrication of the iPCM devices and multifunctional devices. The pattern was consisted of squared areas (corresponding to the active areas in device cells) from 50 to 10 μm size. The photoresist gl2000-11, and gl2000-8 with the thickness about 300 nm and pre-annealing at 180 °C for 2 minutes was used. The exposure dose was about 400 μC/cm^2. By checking the photoresist after the exposure (and the sample after the further etching) by the microscope the sufficient accuracy of the patterning was confirmed.

3. 結果と考察(Results and Discussion)

The 50 nm TbFeCo bottom contact layer was grown at room temperature. After the deposition, it was magnetized by applying a 1.5 T external magnetic field and the further fabrication process was performed with the use of lower temperatures (<150 ˚C) in order to prevent demagnetization. A ferromagnetic contact material was chosen to investigate the effects of magnetic field on Ge-Te/Sb-Te superlattice films during growth. iPCM devices grown in the presence of magnetic field showed different switching characteristics than conventional iPCM devices. While for the direct current mode bipolar switching was achieved, when the short pulse mode was used, the RESET state (for the lower voltage threshold then for the SET process) was found to be followed by the SET state resulting in an RV curve shape, inverted from the one that is usually observed in iPCM. Such effects can be associated with the different superlattice structure, obtained for the growth conditions used.
By using a three-terminal device it was shown that the programmable area of the supernalttice in iPCM devices is manipulated predominantly by he electric filed with a lesser impact of the thermal effects.

4. その他・特記事項(Others)

The rest of the fabrication and other research processes were implemented in the National Institute of Advanced Industrial Science and Technology (AIST), within a framework and funded by the project entitled “Innovation of two-dimensional multiferroic functional device utilizing the topological phase transition of the chalcogen compounds and its superlattices” (CREST, JST project).

5. 論文・学会発表(Publication/Presentation)

(1) K.V. Mitrofanov et al., Phys. Status Solidi RRL 2019, 1900105.
(2) K.V. Mitrofanov et al., MRS Spring Meeting 2019, Phoenix, USA, April, 2019.
(3) K.V. Mitrofanov et al., LID 2019, Grenoble, France, June, 2019.
(4) K.V. Mitrofanov et al., FLAMN 2019, St. Petersburg, Russia, July, 2019.
(5) K.V. Mitrofanov et al., MRS Fall Meeting 2019, Boston, USA, December, 2019.
(6) K.V. Mitrofanov et al., PCOS, Atami, December, 2019.

6. 関連特許(Patent)

No patent was granted.