課題番号　　:F-NM-16-0074
利用形態　　:機器利用
利用課題名(日本語)　　:
Program Title (English)　:Multifunctional superlattice materials
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Affiliation (English)　　:National Institute of Advanced Industrial Science and Technology

1. 概要(Summary)

Chalcogenide superlattices, having topological insulator properties and potentially being able to allow the coupling of the switching parameters with the effect of the external magnetic field application, are studied in order to develop two-dimensional multiferroic functional devices. The essential part of the project is the fabrication of the sub-micron scale devices based on the superlattices, with the use of electron-beam lithography.

2. 実験(Experimental)

【利用した主な装置】

- 100kV-EB writer
- 125kV-EB writer

【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 500 nm 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)

During the project the following results were achieved:

- It was shown that by optimizing the fabrication process, SET current of the iPCM devices can be significantly decreased (~70%).
- At least 1000 times faster and 1000 times longer bipolar switching of chalcogenide superlattice than for previously reported GST-alloy was performed.
- Multi-level operation of iPCM and the dependence of the separation of the intermediate resistance states on the switching pulse width was shown (Figure 1).
- It was shown that the use of Bi-Te instead of Sb-Te within the chalcogenide superlattice leads to an improvement of their switching performance (current).

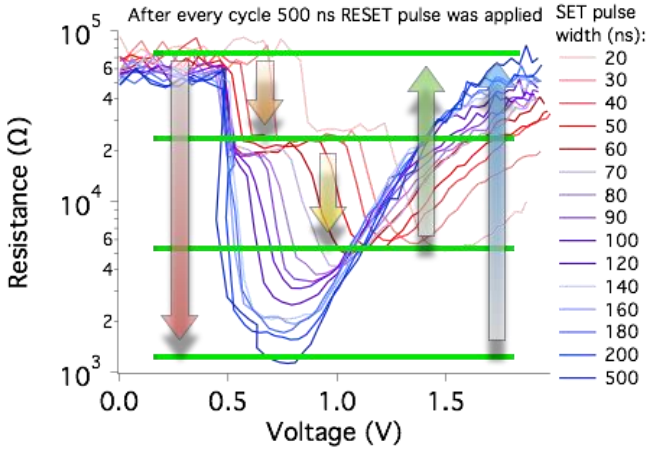

Figure 1. The appearance of the additional (intermediate) states in iPCM device as a function of the SET pulse width.

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)

K. Mitrofanov et al., "5th International Conference Smart and Multifunctional Materials, Structures and Systems (CIMTEC2016), June 5 – 9, 2016.

6. 関連特許(Patent)

No patent was granted.