IRES 2018 Group Assignment

Understanding RRAM Array Fabrication Process

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1 Paper Reading

Read the article "Face classification using electronic synapses" [Yao et al., 2017], a publication of our group on Nature Communications. The supplementary materials have also been attached.

This article will help you understand:

- How RRAM works?
- How RRAM array works?
- Why RRAM?
- What challenges?
- How to overcome these difficulties?
- What is the fabrication process?
- What applications can we use RRAM for?

2 Questions

Answer the following detailed questions (get more information from wikipedia, scholar.google.com, etc., if necessary):

2.1 General Questions

1. What is the typical I-V characteristic of a RRAM device? Try to sketch its I-V curve to show your idea.

   (Hint: Refer to the research of Leon Chua, regarded as the father of memristor.)

2. What are the advantages of RRAM as electronic synapses? And what are the drawbacks?

   (Hint: An electronic synapse is used as the connector between pre-neuron and post-neuron in artifical neural networks. You can compare RRAM synapses with classical electronic synapses, biological synapses on operation speed, energy consumption, area, reliablitiy, scaling down, etc.)

3. What's the difference between unipolar RRAM and bipolar RRAM? Describe how they work respectively. Is the RRAM device mentioned in [Yao et al., 2017] unipolar or bipolar?

4. What is the physical mechanism of the resistive switching process in general?

   (Hint: Refer to the "Introduction to RRAM" material I sent to you before, if necessary.)

5. What is the SET and RESET process of a RRAM device?

6. What does "1T1R" mean? And why we use "1T1R" architecture?

2.2 Questions on the Article

1. Why there is always an abrupt transition during the SET process? How does [Yao et al., 2017] overcome this difficulty?

2. What method does [Yao et al., 2017] use to reduce the variations of RRAM cells in a software way?

3. What is the RRAM array size in [Yao et al., 2017]? What is the original input image size? How to fix the mismatch?

4. What materials does [Yao et al., 2017] use for each layer of the RRAM stack? Point out the function of each layer.

2.3 Fabrication Questions

1. What is the fabrication workflow of the RRAM stack in [Yao et al., 2017]? Detailed fabricating parameters (temperature, thickness, etc.) are prefered.

2. How to control the ratio of different materials during deposition process?

3 Teamwork

Describe how you cooperate on this group assignment.

References

[Yao et al., 2017] Yao, P., Wu, H., Gao, B., Eryilmaz, S. B., Huang, X., Zhang, W., Zhang, Q., Deng, N., Shi, L., Wong, H.-S. P., et al. (2017). Face classification using electronic synapses. *Nature communications*, 8:15199.