

A SUPERCONDUCTOR-BASED MEMORY DEVICE USING A SWITCHABLE RESISTIVE ELEMENT SUITABLE FOR SUPERCONDUCTING COMPUTING

Fields of use

Superconducting computing

Current state of technology

Concept stage

Type of cooperation

Technical cooperation agreement,
Research cooperation agreement

Intellectual property

Patents applied for but not yet granted

Developed by

Jožef Stefan Institute

Contact

Jožef Stefan Institute,
Jamova cesta 39,
1000 Ljubljana,
Slovenija

Phone: + 386 1 47 73 224

E-mail: tehnologije@ijs.si

Web site: <http://tehnologije.ijs.si/>



Summary

Developing a superconducting computer that could outperform conventional computers with high speed and low power consumption has been a desirable goal for a long time. One of the remaining obstacles still is the development of a fast, scalable, low power memory. An example of a known proposal for a memory solution is a superconducting nanowire memory element operated by nanowire cryotrons. Various hybrid devices also have been developed in the past. Here, a memory device that combines a switchable resistive element, with a superconductor element to control the switching, is proposed.

Description of the invention

The memory device consists of a narrow channel made of a memristive nonvolatile charge density wave (CDW) material.

The memristive non-volatile CDW material may be referred to as a switchable resistive element. The normal state after cooling down to cryogenic temperature is high resistance state. Above a certain current threshold, the resistive element is caused to undergo a transition to the low resistance state which constitutes the Write operation. The reverse transition from the low resistance state to the high resistance state of the memristive element (the Erase operation) is caused when the current exceeds a certain but different value of critical current, changing the shunt resistance to a high value. The superconducting memory device described may be in the form of a nanowire or a three terminal device such as nano-cryotron (nTron) device. The suitable device operating temperature is 40 K or lower. The width of the device is few tens of nm enabling high scalability.

Main Advantages

A hybrid superconducting memory device proposed combines a superconductor element in parallel with a switchable resistive element. The proposed device is characterized by:

- Ultrafast switching speed <40 ps,
- Two- or three-terminal operation,
- Scalability, ultralow switching energy (due to the ability to use low-energy memristive elements) <0.25 pJ/bit,
- Low-temperature operation,
- Ease of integration, simple 2-element circuit design and compatibility with superconducting electronics, particularly superconducting flux-quantum electronics.

Partner Sought

The proof of concept for the memory device proposed would be the first step of cooperation.

The technical cooperation is sought for the development of the prototype device.

The research cooperation agreement is sought for creating a partnership and further research toward a fully functional memory chip. The partner would need to provide a technology for designing, testing and manufacturing of the superconductor-based integrated circuits.