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Two-terminal Memory Device with Full Write and Read Functionalities (20160423, Dr. Jian-Ping Wang)

Technology No. 20160423

Combines Spin Hall Effect and Unidirectional Spin Hall Magnetoresistance

A two-terminal memory device combines the spin Hall effect for switching/writing and unidirectional spin Hall magnetoresistance (USMR) for detection/reading. The memory device, with two-terminal write and read operations, acts like an MTJ but carries greater switching efficiency. To write, a strong pulse is applied across the device so that spins are generated by spin Hall effect in the channel and absorbed by the top magnet. The magnetization is then switched from left to right. To read, a mild sine wave modulation is applied and the voltage signal is sensed. This device could support magnetic crossbar memory, 3D memory architectures and magnetic memory architecture computations. Device fabrication is much simpler than three-terminal spin Hall switching devices and its design allows for wafer scale production.

More Efficient Spin-orbit Torque Embedded into Crossbar Memory

This device combines the spin-orbit torque switching by spin Hall effect or TIs as the writing mechanism, with USMR as the reading mechanism. It is a simple yet potentially powerful design of a memory/logic device and features only two terminals, allowing more efficient SOT switching while the two-terminal design allows it to be easily embedded into mature crossbar memory architectures, with or without selectors (e.g., used with MTJs in STT-RAM). This technology allows for switching of in-plane magnetization with the spin Hall effect and reading the magnetization state without adding a third terminal, thus enabling a two-terminal spin Hall device that overcomes limits of all current spin Hall devices (three-terminal) for memory and some computation applications.

BENEFITS AND FEATURES:

- Combines spin Hall effect (writing mechanism) with USMR (reading mechanism)
- Two-terminal design
- May be combined with other effect including electric field and strain effects to further assist switching
- Easily adopted with current STT-RAM technologies
- Acts like an MTJ but carries greater switching efficiency
- May support magnetic crossbar memory and 3D memory architectures

APPLICATIONS:

- Spin memory and logic
- Electronic industries
- Mobile devices
- STT-RAM technologies

Phase of Development - Early/Physics observation

Researchers

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Publications

Unidirectional spin-Hall and Rashba−Edelstein magnetoresistance in topological insulator-ferromagnet layer heterostructures
Nature Communications, 09 January 2018; 9, 111

External Links

Nanospin Research Group