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Spin Hall Effect Switching of Perpendicular Magnetization (20150186, Dr. Jian-Ping Wang)

Perpendicular Magnetization Switching without Externally Applied Field

A new material structure allows switching of perpendicular magnetization (using the spin Hall effect) without an externally applied magnetic field. This design for spin based memory and logic devices is compatible with current standard CMOS technology. It can be incorporated with low energy, nonvolatile memory and logic structures and provides an alternative means to write data stored in magnetic tunnel junction (MJT) structures that does not involve current passing through the MJT. By integrating this device with MJT devices used in spin transfer torque magnetic random access memory (STT-RAM), it can reduce energy consumption and lessen the chance of device breakdown. The new structure can easily be adopted with current STT-RAM technology for actual devices and could address current issues with STT-RAM. Its structure allows for wafer scale production of spin Hall devices that do not require an external field for operation, and its simple and inexpensive current stack preparation does not involve any major modifications. The design may enable more widespread use of the spin Hall effect for memory and logic applications.

Note: This technology has been exclusively licensed. If you have questions, please contact the University of Minnesota's Office for Technology Commercialization.

No Wedge Structure Field Required

Previous spin Hall based devices use either an in-plane magnetic layer or a perpendicular magnetic layer with an applied external field. Switching of perpendicular magnetization without a field in a wedge structure (where a portion of the device is perpendicular and a portion of the device is in-plane in the lateral direction) severely limits the structure's scalability, which is critical for industrial applications. This new perpendicularly magnetized spin Hall structure and device features uniform dimensions and increased scalability, since the entire magnetic film consists of either a partially perpendicular film or multiple layers, each with either in-plane or perpendicular magnetization. It does not rely on a wedge structure to achieve switching without an external applied field, and does not require an externally applied field to achieve switching. It incorporates perpendicular materials rather than in-plane materials, which is preferred for memory applications due to benefits such as scalability and stability.

BENEFITS AND FEATURES:

- Perpendicular magnetization switching without externally applied field
- Incorporated with low energy, nonvolatile memory and logic structures
- May be combined with other effects (e.g., electric field and strain effects) to further reduce switching energy
- Easily adopted with current STT-RAM technology for actual devices
- Simple and cost-effective; current stack preparation does not involve any major modification
- Reduced energy consumption
- Lower chance of device breakdown

Technology ID
20150186

Category
Engineering & Physical Sciences/Design Specifications
Engineering & Physical Sciences/Instrumentation, Sensors & Controls
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APPLICATIONS:

- Spin based memory devices
- Logic devices
- Standard CMOS technology
- Data stored in magnetic tunnel junction (MJT) structures
- Spin transfer torque magnetic random access memory (STT-RAM)

Phase of Development - Proof of concept

Researchers

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External Link (ece.umn.edu)

Publications

External-Field-Free Spin Hall Switching of Perpendicular Magnetic Nanopillar with a Dipole-Coupled Composite Structure

arXiv, arXiv:1603.09624v2; 10 Oct 2017

External Links

Nanospin Research Group