Tohoku Univ. Technology

Spin Wave-Based Address Encoder/Decoder

Next-Generation Information Processing Beyond the Limits of CMOS

Artificial skin sensor
(10^{10} Units)
J. Kim, et al., Nat Comm 5 (2014).

3D displays for medical
(10^{12} pixels)
https://rjbourgess.files.wordpress.com/2012/03/hospital11.jpg

Overview

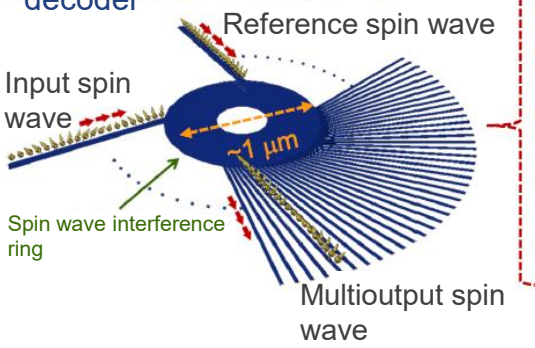
With the advancement of the information society, there is increasing demand for devices with lower power consumption, higher speed, and smaller size. However, conventional semiconductor integrated circuits (CMOS) are approaching physical and technological limits in scaling and integration density. This is mainly because charge-based devices inevitably suffer from heat generation and signal delay due to electron transport.

To overcome this, researchers have successfully demonstrated the proof-of-concept of information transmission technologies and logic devices that utilize spin waves—specifically magnons propagating in a magnetic insulator such as yttrium iron garnet (YIG)—as information carriers, thereby eliminating the need for electron transport.

This invention relates to an address encoder/decoder circuit that employs magnons and uses a ring-shaped interference region to convert complex input signals into corresponding output addresses.

Spin waves with different phases and wavelengths can be multiplexed

Spin wave multiple input address decoder



- Shortening of wavelength
  - ➡ Ultrathin magnetic oxide film (~10nm)
- Overwhelmingly low loss
  - ➡ Bulk-level single crystal (~0.1 deg)
- Multiple input/output
  - ➡ High-frequency magnetic circuit + Oxide materials
- Phase modulation of spin waves
  - ➡ Magnonick crystal technology

Product Application

- **Artificial skin** with sensor arrays capable of human-like sensing
- **3D displays** for medical and entertainment applications

Related Works

[1] DOI : 10.1038/s41598-019-52889-w
[2] DOI : 10.1038/s41598-017-08114-7
[3] https://www.tohoku.ac.jp/japanese/2024/01/press20240131-01-spin.html

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