Seminar: Teruo Ono

Institute for Chemical Research, Kyoto University, Japan
Center for Spintronics Research Network, Kyoto University, Japan
International Center for Synchrotron Radiation Innovation Smart, Tohoku University, Japan

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3D domain wall motion memory with artificial ferromagnet

Biography

Teruo Ono received the B.S., M.S., and D.Sc. degrees from Kyoto University in 1991, 1993, and 1996, respectively. After a one year stay as a postdoctoral associate at Kyoto University, he moved to Keio University where he became an assistant professor. In 2000, he moved to Osaka University where he became a lecturer and an associate professor. Since 2004, he has been working at Kyoto University, where he is now a professor. He has published over 280 technical articles in peer-reviewed journals, including book chapters and review articles, and has given more than 90 invited presentations at international conferences. He served as conference co-chair of the 8th International Symposium on Metallic Multilayers (MML) in 2013, and on the program committees of various international conferences on magnetism and spintronics.

Abstract

Racetrack memory using domain wall (DW) motion in ferromagnetic nanowires is a potential candidate for future memory technologies [1]. However, there are still problems that hamper the commercialization. First, lowering consumption power is crucial for practical application. Second, a precise control of DW position is a problem to be solved. Smaller DW width is preferable for higher density memory. Here, we propose a new type of 3D DW motion memory with an artificial ferromagnet and study its feasibility by micromagnetic simulation.

3D DW motion memory proposed in this study consists of an array of cylindrical artificial ferromagnetic wires, which is composed of periodically stacked bilayers of a bit layer with strong magnetic anisotropy and a DW layer with no magnetic anisotropy [2]. The data is written by flipping the magnetization of the bottom bit layer using the spin-orbit torque induced by the current in the word line. The written data can be shifted to the arbitrary position in the artificial magnetic wire by the appropriate current injection through the wire. By repeating the writing and shifting, an arbitrary information sequence can be stored in the magnetic wire. The data can be read out with the topmost magnetic tunnel junction while the data is being shifted by the current through the wire. Micromagnetic simulation shows that the precise DW position controllability, narrow DW width down to 3 nm, and low DW motion current down to 2 × 1010 A/m2 can be achieved with feasible material parameters [2]. Furthermore, it is found that the high thermal stability and the low DW motion current can be achieved simultaneously [3]. Data-writing and shifting processes for 2-bits memory have been demonstrated [4]. Although the originally proposed method for reading information from this device is destructive, we proposed a novel nondestructive readout method, leveraging the magnetization dynamics induced by the spin transfer torque [5].

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