구두발표 III-1

Spin-Flop Switching for High Density Magnetic Random Access Memory

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In this work, micromagnetic computer simulation has been carried out to investigate the suitability of the new method of magnetization switching for high density MRAM, which was recently proposed by Lenoid Savtchenko et al. [1]. Various parameters of t, J and H_u were considered in the simulation, particularly to examine their effects on the magnitude of H_s. In both the toggle and direct write modes, H_s decreases with decreasing J. However, the opposite trend is observed in the t dependence; as t increases, H_s increases in the toggle mode while it decreases in the direct write mode. This opposite behavior may be due to different dominant factor for H_s depending on the write mode: H_{sf} in the toggle mode and H_d in the direct write mode. An optimum value of H_u is determined to be approximately 15 Oe, by considering the bi-stability of bits in the present circular geometry and the role of H_u in increasing H_s. The results for the window for bit-writing calculated over a wide range of H_{word} and H_{bit} show that a very wide switching window is observed in the toggle mode, but the magnetic fields required for magnetization switching are very high being roughly in the range 150 Oe $< H_{word}, H_{bit} <$ 400 Oe. This observation is in agreement with common expectation. In the direct write mode, the window for bit-writing is narrower and also very asymmetric with respect to H_{word} and H_{bit}, the switching region extending deep into the H_{bit} direction but not into the H_{word} direction. This simulation result is in contrast with the original estimation of typical "L" shaped, wide and symmetrical write window [1]. Both reasonably low values of H_{word} and H_{bit} and a wide write window are obtained at the asymmetric condition $H_{word} > H_{bit}$, specifically, 100 Oe $= H_{word} =$ 150 Oe and 70 Oe $= H_{bit} =$ 100 Oe. The present results indicate that the new method in the direct write mode can be suitable for high density MRAM.

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[1] Leonid Savtchenko, Bradley N. Engel, Nicholas D. Rizzo, Mark F. Deherrera, and Jason Allen Janesky, U.S. Patent No. 6,545,906 (Apr 8, 2003).

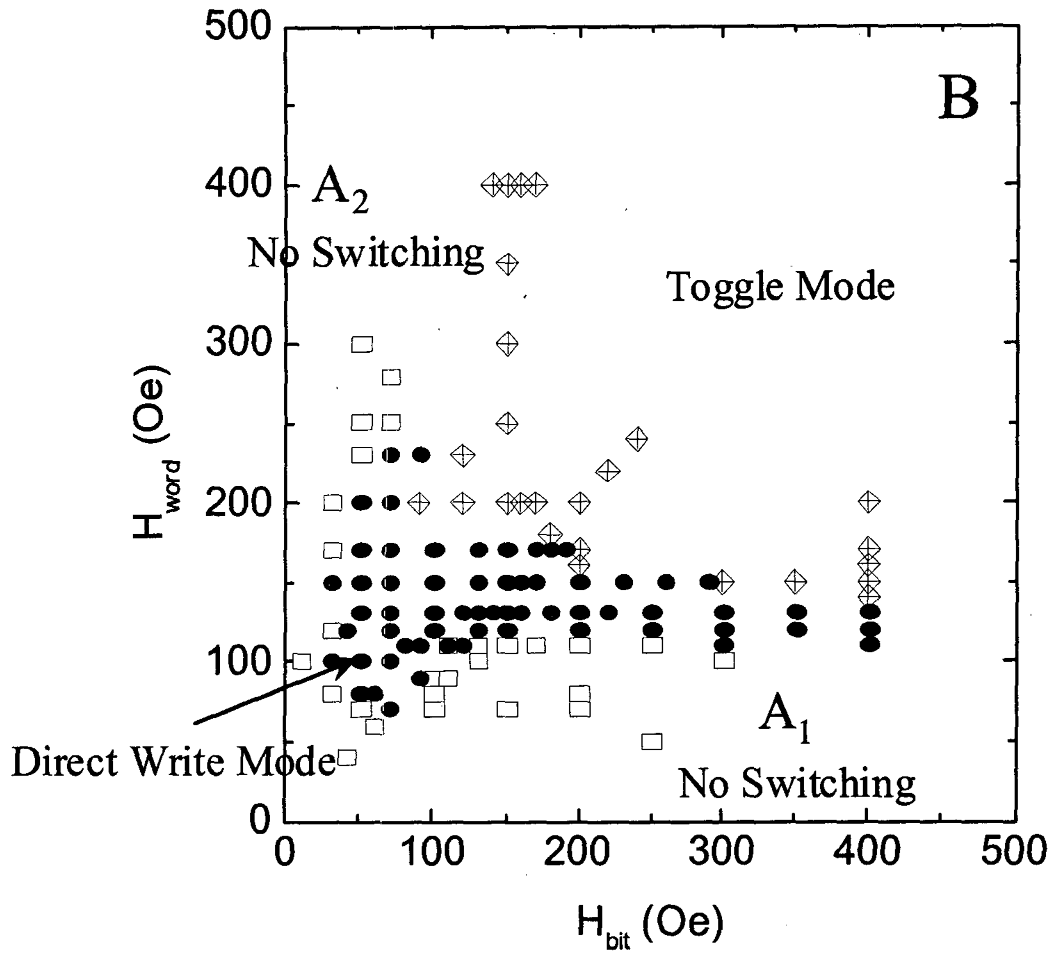

Fig.1. The switching window in the toggle (diamonds combined with pluses) and direct write modes (filled circles). The conditions used in the simulations are: J = - 0.05 erg/cm^2, t = 2 Å and H_u = 15Oe. The regions of A_1 and A_2 indicate no switching (denoted by unfilled rectangles). The region B indicates an undetermined state.