# Current-induced Domain-wall tilting in Ferromagnetic Nanowires with Perpendicular Magnetic Anisotropy

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Magnetic thin films with perpendicular magnetic anisotropy (PMA) provide useful features for application to the domain-wall-based memory devices such as the magnetic random access memory and the racetrack memory [1]. To achieve a high domain-wall speed for fast operation, it is crucial to inject a high current density into the devices. However, such high current density also induces sizeable Oersted field inside the devices, which in turn affects the domain-wall configuration.

In this study, we have derived an analytic prediction on the domain-wall deformation caused by the Oersted field, using the variational principle to get the energy minimum state. An exact solution on the tilting angle of the domain wall is then achieved as a function of the current density, the wire geometry, and the magnetic properties. The tilting angle increases as the current density increases, and, at a certain current density, the domain becomes split into bi-domains across the nanowire. This is related to the upper bounds of both the feasible current density and the maximum data storage density. We have confirmed the validity of the theory by comparison with the micromagnetic simulations.

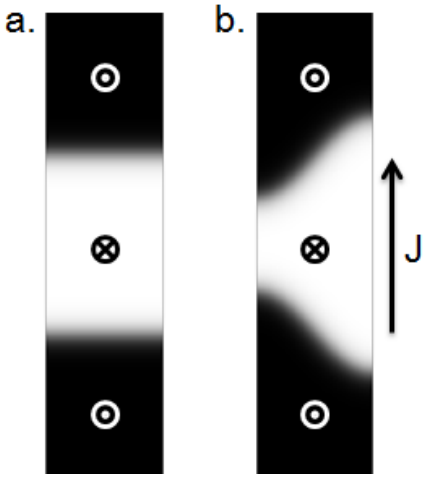


Fig. 1. Illustrations of (a) the initial domain state and (b) deformation of the domain-wall after the injection of current

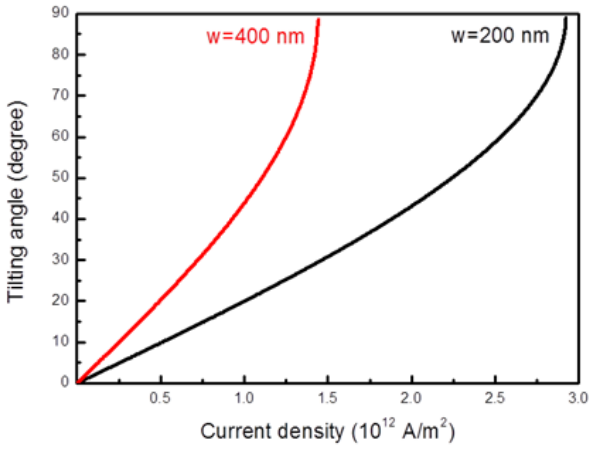


Fig. 2. Domain-wall tilting angle at the center of the nanowire as a function of the current density for the different wire widths

## 참고문헌

[1] S. S. P. Parkin *et al.*, Science **320**, 190 (2008)